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Moving a Big Bridge

IT has come to be an accepted feature of modern engineering technique that any ordinary bridge can be replaced with negligible interruption to traffic. Falsework is erected above and below the old span. When the new span has been completely built upon the first of these temporary foundations, the old structure is raised from its supports and floated down stream onto the second, while the new span is put in its place by the same method. Even when it is necessary to lay rails across the joints where span and approaches meet, it is quite usual for the entire process to be completed with an interruption to traffic of only a few minutes—four and a half, we believe, is the record.

These remarks, of course, apply to a moderately short bridge of a single span. Where it becomes necessary to replace a long structure of several spans the problem becomes more complicated, and railroad engineers are prone to solve it by a relocation of the road for a short distance on each side of the river. This puts the work upon the same basis as the erection of a new bridge where none existed before; traffic flows through its old channels until the bridge is ready, whereupon it is diverted to the new route. But occasionally the track is so situated with respect to natural features or surrounding industrial developments that such a shifting is not feasible; and then the method employed for the short bridge must be adapted, as well as may be, to the long one.

A notable instance of this sort of thing was to be seen at Omaha on Saturday, December 23d. The Union Pacific Railroad bridge connecting Omaha with Council Bluffs is used by all the railroads entering the city from the east, with the single exception of the Illinois Central. Carrying over three hundred trains per day, the old bridge has become inadequate, and was replaced, on the date named, by a larger and heavier structure. There are four spans, of a total length of a thousand feet; the old structure weighed, *in toto*, about 2,750 tons, and the new one almost twice as much. So it will be seen that the bridge-movers' job was a formidable one.

Nevertheless, it was successfully accomplished, and without the slightest hitch. The old bridge was lifted from its piers and moved 28 feet, all in one piece, and not each span separately. In precisely similar fashion the new bridge was slid over and eased into place. For this task of moving and raising and lowering 5,500 tons five donkey engines were employed; and huge traveling cranes were held in readiness for the emergency which did not arise. The bridge structure was moved on big rollers of solid steel running on tracks of 90-pound steel rails; and between the rollers and their load was placed a similar track to act as upper bearing surface.

It is to be noted that in a task of this character the critical aspect of the engineers' problem is not found in the direction of power supply. A freight train of 5,500 tons would excite no comment whatever; and as a matter of fact, the combined horse-power of the five engines used in the instance before us was only 320. It is rather to the moving of his load smoothly, without jars or sudden starts, that the engineer must address his attention; and more especially to setting it down gently in precisely the place he wants it. The husky citizen who can seize a piano by one corner and haul it all over the house, but who can only let go of it by dropping it with a crash that arouses the whole neighborhood, can testify to the truth of these statements.

That this phase of the problem was here met with complete success is demonstrated by the fact that the old, lighter span was in motion only four and a half minutes, while to shift the heavy new structure to its final resting place was a matter of but ten and a half minutes. The old bridge was closed to traffic at 11:10 A. M., its successor was open to trains at 3:40 P. M. Hence it will be seen that of the time required, less than 6 per cent was devoted to the actual work of moving the two bridge structures, the balance being taken up in arranging and rearranging the tackle, and in such work looking to the firm anchoring of the new bridge as was necessary before trains could safely be allowed to use it.

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At left, old bridge being moved off the permanent foundations; at right, new structure on its falsework

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Closer view of the shifting of the old bridge onto the falsework to make room for its successor

Anthrax Among Tannery Workers

ANTHRAX, which is especially a disease of the lower animals, chiefly cattle and sheep, is occasionally transmitted to man. In such cases the bacillus is derived from some domestic animal, or from some commercial animal product, especially hides, hair, or wool, and does not penetrate the unbroken skin, but enters some abrasion, scratch or cut. It occurs particularly among veterinarians, brush makers, leather workers, tanners and farmers. During the spring and early summer of 1916 Massachusetts experienced the most severe outbreak of human anthrax in its history, and a report upon it has just been published by the U. S. Public Health Service. Of 25 reported cases, 23 were among persons handling hides, and 20 of these cases were infected from a common source; viz. a cargo of dried "China" hides. Four cases terminated fatally.

The statistics of the foot-and-mouth outbreak of 1914-1916, recently published by the U. S. Department of Agriculture, show that the disease extended to 22 states and the District of Columbia. A total of 172,222 animals were slaughtered, and the campaign of eradication cost the federal and state governments about $9,000,000. This large sum is, however, trivial compared to the colossal damage that would have been inflicted upon the country if the disease had gotten beyond control and become permanently established in the United States. The quarantine was gradually removed as areas and states were freed of infection, and the last restrictions were rescinded June 5, 1916. Congress has made a special appropriation of $1,250,000, to be available for the eradication of this and other contagious diseases of animals in cases of emergency.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

A Court of Patent Appeals Needed

WHEN the Congress in 1893 established the present Circuit Courts of Appeals, it had in mind the lightening of the burden of the Supreme Court and also the expediting of the final adjudication of controversies in certain cases. The calendar of the Supreme Court had become loaded down with cases taken there on appeal from the various inferior courts, to such an extent that the work of that court was far in arrears and it was no unusual thing for a case to be on the docket for several years before it would be reached for argument and final disposition.

The Circuit Courts of Appeals established in 1893, were given appellate and final jurisdiction in many cases, and while they have materially lightened the labors of the Supreme Court and have shortened the time required to obtain a final settlement in certain cases, yet as there are nine different and independent Circuit Courts of Appeals, all hearing and finally disposing of the law and facts in the appeals in their own circuit, the result has been far from satisfactory in patent cases, owing to the lack of uniformity of interpretation of the patent laws and their application to the facts in each case.

When appeals in patent cases were heard by the Supreme Court, there was almost a certainty that the precedents of that court on the law as applied to any given state of facts would be followed, and there was no uncertainty as to how that court would interpret the law, for the reason that the meaning of the law on nearly all points had been discussed and settled by that court in previous cases. At the present time, however, the Circuit Courts of Appeals made up as they are, of both circuit and district judges, who are constantly changing, oftentimes fail to properly interpret the law as laid down in the decisions of the Supreme Court and to apply that law properly to the state of facts in a particular case; and as a Circuit Court of Appeals in one circuit is not obliged to follow that of another circuit, there is a constant recurrence of conflicting opinions on the same law and substantially the same facts, insofar as patent cases are concerned.

Many of the federal judges dislike to try patent cases because of the highly technical character of the subject matter; and it frequently happens that in the District Courts and the Courts of Appeals, these highly technical cases involving, as they do, abstruse mechanical, chemical and other scientific questions, are decided by judges who are utterly lacking in the ability to understand the subject matter. Naturally, in the District Courts some rather remarkable decisions are encountered, and their rulings are oftentimes so diverse as to be antipodal. This is to be expected; but there should be some one court before which the matter can be taken on appeal and in which the parties may expect to find a reasonably and fairly certain degree of uniformity in the application of the law to any given state of facts.

We understand that there is a proposition before Congress to increase the number of the federal judiciary and such increase seems to be necessary, because the volume of business before the courts is constantly increasing and it now appears to be beyond the efforts of the courts to dispose of it within a reasonable length of time; but instead of assigning all of these new judges to the various circuits, it has been proposed that Congress establish a Court of Patent Appeals and assign thereto at least nine of the contemplated additional circuit judges to constitute such court; that this court have final appellate jurisdiction of all patent causes and hold its sessions at Washington, D. C., and at several other designated places throughout the United States, and we cannot too strongly endorse this suggestion. Should a Court of Patent Appeals be established, and the members thereof be selected because of their technical as well as legal qualifications, we would again have that uniformity of interpretation of the laws relating to patents and their application to the peculiar situation existing in patent cases, which is to be found in the decisions of the Supreme Court and which resulted, as much as anything else, in the promotion of the useful arts and sciences contemplated by the Federal Constitution and to which our wonderful industrial progress is to be attributed.

The Ideal Submarine

IT seems to be necessary for every type of warship to pass through a phase of its development in which the matter of size is the all-absorbing question. Usually the disputants are divided into two schools, one of which believes in putting displacement into the biggest practical units, combining the maximum of speed, power and defense, the other believing that displacement should be distributed among a large number of smaller craft, which though individually weak would be overwhelming when they attacked in mass.

Invariably (and students of naval construction should take careful note of this) the advocates of great power and speed have won out, and in this connection it is significant that the latest designs for our own Navy call for 42,000-ton battleships, 35,000-ton battle-cruisers, 7,000-ton scouts and 1,200-ton destroyers, all of these classes, save the battleships, to have 35 knots speed.

It is only when we come to the submarines that we find the old controversy still raging. A few of our naval men and, alas, the majority of our Congressmen, are still clinging to the belief in the efficiency of mosquito craft. They believe that a host of 500-ton coast-defense boats of moderate speed and small sea-going power, would afford a better defense than a smaller number of boats, twice their size, of greater speed, of wide radius of action, of great powers of offense, and capable of going out with the main fleet to tackle the enemy a thousand miles off shore, if need be.

The principle of compromise controls all naval construction and it is particularly insistent when we come to the submarine. The sea-going officer asks for certain qualities in an ideal submarine, and the naval constructor too often finds that within the limits of size imposed, the combination of these qualities in the degree asked for is impossible. It is largely because of this fact that the Department some time ago detailed a naval constructor, Mr. E. S. Land, to duty with the submarine flotilla, and during a period of many months he lived aboard our submarines, making many trips of greater or less duration. This practice of sending naval constructors to sea for observation is excellent, and we believe that it could be extended to very good effect. A notable instance was the dispatch of Naval Constructor Robinson with the fleet in its famous voyage around the world. Indeed, we are of the opinion that it would be advisable for every naval constructor, at stated intervals, to spend a certain amount of time with the fleet.

In his recent testimony before the House Committee on Naval Affairs, Mr. Land gave it as his opinion, based upon his experiences at sea, that the ideal boat for the United States Navy would be one of between 750 and 950 tons displacement and from 225 to 250 feet in length. A preliminary estimate shows that a boat of this size could be built with a surface speed of from 17 to 19 knots and a submerged speed which might reach 14 knots. It could carry a powerful armament of torpedoes and rapid-fire guns, and it would provide comfortable berthing accommodations for the crew—this last a most important consideration in submarine work. A submarine of this size would be capable of keeping the sea and maneuvering in company with the main fleet; something which our present submarine of 400 to 500 tons displacement cannot do.

Since increased size brings such manifest advantages, the question naturally arises: Why not go yet higher and build submarines of 1,200 to 1,500 tons displacement? The answer is that submarines of this size, with a length of from 300 to 400 feet, would be impracticable, or at least, inadvisable; first, because they would be too slow in submerging, and secondly, because when submerging, except at very small angles of inclination, they would run the risk of reaching dangerous depths before they could be controlled; dangerous depths being those at which the nose of the boat may strike bottom, or the hull be subjected to crushing stresses, due to a water pressure, beyond the strength of the boat.

Even at small angles of inclination the manipulation of a submarine, 300 to 400 feet long, at high speed below the surface might carry the boat to dangerous depths before she could be controlled. A speed of 12 knots is equivalent to 20 feet per second; and it would not take many seconds to carry the vessel beyond the danger line.

Swift submergence, so necessary when attacked, becomes more difficult with the increase in size of the submarine, and it is believed that 800 to 900 tons marks the limit beyond which submergence is too slow to ensure safety against being rammed by a destroyer or submarine chaser. Submergence depends upon ability to destroy the reserve bouyancy by filling the ballast tanks, and the speed of filling depends upon the size of the valves. If the valves are big they are difficult to keep tight and the pressures upon them are such that they cannot be operated rapidly by man-power.

Limitations of space prevent our following this argument any further; but attention should be drawn to the fact that 800 tons is about the displacement of the German sea-going submarines which lately have ventured so far afield. This type preponderates, so far as numbers are concerned, in the navies of England, Austria and France. Japan and Russia are building 800-ton boats, and at the time of the Naval Affairs Committee examinations last year, reliable information came from Italy that they had abandoned the 400 to 500-ton type and were building only boats of from 750 to 950 tons.

Have Motion Pictures Changed Us?

TO appreciate fully the wonder of motion pictures it is necessary to recall the various epochs in the history of this later-day form of entertainment. We all recall the pioneer days of the films, when a hundred or two hundred feet of scenic or trick pictures were projected on the screen of the museum or theatre as a special feature. Next came the picture theater or nickelodeon, which appealed to the lower classes who gladly paid their nickels for an hour or two of entertainment in the form of flickering rough-and-tumble film plays, which, in all but one or two exceptions, were of the most mediocre character. Close on the heels of the second period came the third, in which the higher grade photoplay of one reel came into being, accompanied by the better class of picture theater appealing not only to the poorer among us, but to representatives of the middle class. The latter were attracted by better theaters, better features and better surroundings, all due to the raising of the price of admission from five cents to ten and even fifteen cents. Enter then the fourth stage, which is that of to-day. We have splendid films in single reels and in multiple reels, affording a quarter of an hour's entertainment or several hours from one picture alone. The better films are masterpieces in every sense—excellent plots, accomplished and renowned players, and wonderful scenery.

Surely the motion picture as an entertainer has more to offer than mere novelty. Otherwise, it would long since have gone the way of other novelties—oblivion. Instead, it has prospered; from an insignificant side show, little more than an improvement on the "penny arcade" or slot-machine halls of a decade or so ago, it has become a formidable competitor of the legitimate stage, seriously encroaching on what has always been considered the exclusive premises of the latter.

All of which leads up to the question: Why is it that motion pictures are so popular? Another question: Why are they able to compete side by side with our best plays?

The answers are not difficult to find. For one thing, it is safe to assume that if motion pictures had been introduced a generation ago they would have been little more than an amusing and short-lived fad. People then had more time for their reading and for theaters. This does not mean that the people of to-day have no time for the theaters, for we know it to be a fact that the city folk go and go often to all the leading plays; but it is equally true that it is difficult indeed to hold the interest of a metropolitan audience through three acts of a drama when the plot can be anticipated in the first act. So it is that a play with a simple plot which is slowly worked out in three acts, without unusual dialogues or other features to enliven the action in order to keep the minds of the audience fully occupied, is doomed to failure by the very ennui of the theater patrons.

Here, then, lies perhaps the main explanation of the popularity of the motion pictures. Modernism calls for abbreviated action; and photoplays, as a general rule—and we are only considering generalities in this discussion—are stories told more or less in synopsis form. The plot is unfolded in the least possible time, and only the action of a story is utilized. Thus, if a stage play requires three hours, in the photoplay it is pictorially told in one hour, and just as effectively. The only exception is to be found in those plays that depend for their success on clever volleys of dialogue.

And now that the modern public has found its call for briefness met by the motion pictures, it has come to a pass where it wishes other things treated in the same manner. For instance, there is a growing demand for one-act playettes; an afternoon's or evening's entertainment to be made up of two or three single-act plays, each complete by itself. The idea has been tried out in New York and has been approved by the audience. In fact, it is even rumored that eventually the three-act play must give way before a program calling for two or three single-act plays, to meet the present-day psychology of theater-goers. Then again, to some extent the briefness idea fostered by the screen play is reflected in the demand for short stories in modern literature. In a recent contest conducted by a leading metropolitan daily the winning stories were noticeably based on motion picture techique—they were brief and full of action and devoid of long pauses between sub-climaxes.

Aeronautical

Kite Balloons for Our Navy.—The U. S. S. "Nevada" and "Oklahoma" are being equipped by the Navy Department for testing kite balloons for spotting purposes this year at Guantanamo, according to a statement made by Capt. Josiah S. McKean, U. S. A., before the House Naval Affairs Committee. They will cost from $4,000 to $6,000 each, will carry two men each and will be about 75 to 80 feet in length and 30 feet in diameter.

Importance Attached to Air Fleet by British.—Speaking recently at Edinburgh, Scotland, on aircraft policy, Lord Montagu of Beaulieu said that when peace came the British air service must be the last to be reduced. A naval invasion might not come; but by means of 100 airships it might come on a scale infinitely greater, which it would need all the British aircraft forces to repel. Of 2,000 miles of coastline, at least 1,000 would have to be defended by aircraft. If in the country a permanent force of 20,000 aeroplanes existed, the cost would not be more than $75,000,000.

Hammond Seaplane Nearing Completion.— Rapid progress has been made by the constructors of the Dunne type seaplane which is being built for John Hays Hammond, Jr., with which he contemplates conducting experiments with wireless control of torpedoes from the air. This machine, which is built to the order of the War Department on designs especially prepared for the trials, will be a heavy weight carrier, lifting a complete load of about 3,100 pounds. The plane has a span of 46 feet and a length overall of 27 feet. The machine alone weighs 2,020 pounds. The radio outfit will weigh about 200 pounds.

The Barlow Aerial Torpedo.—It is reported that the tests of the aerial torpedo of Lester Barlow, a young man who perfected his invention under the auspices of the United States government, have been entirely successful. The torpedo was dropped from 2,000, 3,000, 4,000, 5,000, 6,000 and 7,000 feet. In two of the tests light charges of high explosives were used, and these are reported to have rocked the houses within a radius of four miles from the Mineola aerodrome on Long Island, where the tests were conducted. The Barlow torpedo is seven and a half feet long and weighs about one hundred pounds. Normally inert, the torpedo sets itself after it has fallen 300 feet, and detonates at a given point automatically no matter from what altitude it may be dropped. The torpedoes are carried in traps below the aeroplane, and are released by the moving of a small lever when the sights register on the target.

Magnitude of British Flying Corps.—"The Allies today," states Patrick Y. Alexander in a recent issue of *Flying*, "have complete superiority of the air, but it has been achieved at a tremendous expenditure of efforts and money. We have not less than 500,000 persons in the British air service alone, including thousands of aviators, the mechanics and the manufacturers of aeroplanes and aeronautic supplies. Aeroplanes can be seen in flocks anywhere. Every ship that leaves British ports is escorted by aeroplanes until it is quite a way beyond the Irish coast. We also have large airships which we expect will be superior to the very best Zeppelins. We have in use at present hundreds of small dirigibles, less than 300 feet long, equipped with aeroplane bodies instead of the usual nacelle. They are capable of staying in the air 50 hours and go at a speed of about 35 miles an hour. They are very useful in submarine warfare and coast defense." The speed given here for the "Blimps" is at variance with that mentioned by Capt. Baldwin.

Has Germany the Command of the Air?—The persistency with which war correspondents in Germany inform us that the Teutons have the command of the air on the Western front leads to some confusion as regards the status of aerial supremacy on that front, in view of the fact that the correspondents in back of the Entente lines are just as certain that the air command has long been held by the Allies. Perhaps some light is thrown on this monumental question by a letter written by a German officer of the 170th Regiment, which fell into the hands of the British: "You in Champagne are no longer in the witches' cauldron on the brim of which we are sitting—always waiting the moment to fall in from one side to the other. It is turmoil here again. The air has been alive with aviators the last few days, and still more so with the heavy shells that have been flying over us and onto our poor comrades on our flank and onto our batteries. The number of guns—and of the heaviest caliber—which England now possesses is uncanny, and the amount of ammunition they fire off is fabulous. In addition—what makes it so bad—the aviators are constantly over our lines. They point out our batteries so that they may be peppered, and are always attacking our captive balloons, which is the same as putting our eyes out. Meanwhile the air is black with aircraft, whereas our aviators—but of that why speak? It would be merely pouring water into the Rhine. We could save many thousands of lives if we had the English aviators and gunners."

Astronomy

Encke's Periodic Comet was photographed by Wolf last September when only a month past aphelion; a new record for the distance at which this object has been picked up. Efforts were previously made at the Yerkes Observatory to photograph the comet at aphelion, but, although some suspicious markings were found on the plates, the observers did not feel justified in claiming to have been successful. The object was found on Wolf's plates as a small nebulosity of magnitude 16.5, with a central condensation. The comet is expected to reach perihelion about March 25, 1918.

Parallax of 61 Cygni.—Contribution No. 29 from the Observatory of Columbia University contains a useful history by Mary M. Hopkins of the observations heretofore made on the parallax of the famous star 61 Cygni, from Bessel's original determination, in 1838, down to the present day. This star is distant about 10 light-years from the solar system, and only six stars are known to be nearer. The author tabulates all the observations, showing the methods of observation (in recent years mostly photographic), comparison stars used, the names of the observers, the years of observation and of publication, and the parallax obtained together with its probable error.

A Remarkable Variable Nebula.—Two notes in the *Monthly Notices* of the Royal Astronomical Society, accompanied by photographs, deal with the remarkable changes in shape and brightness of a small nebula which appears to be physically connected with the variable star R Coronæ Australis. A large series of photographs of this object was made at the Helwân Observatory with the Reynolds 30-inch reflector during the years 1911 to 1915. The nebulosity is concentrated at one side of the variable star and behaves as if it might be matter discharged from the star when at its maximum brightness, as well as illuminated by it. The nebula is sometimes very bright and attached to the star, and at other times very faint and separated from it. Mr. Knox Shaw, who took the photographs, suggests that the movements of some absorbing medium between us and these bodies may account, in part, for their rapidly changing appearance.

A Cause of Discrepancies in Solar Rotation Measurements.—The well-known spectroscopic method of measuring the velocity of a star in the line of sight ("radial velocity") has frequently been applied to the measurement of the sun's rotation, but the results obtained have been strikingly discordant. Thus values for the equatorial rotation velocity have been found ranging from 1.86 to 2.11 kilometers per second, and different values have been obtained from observations on different spectral lines at the same time. A plausible reason for these conflicting results has recently been suggested by R. E. De Lury, of the Dominion Observatory, Ottawa. He points out that the effect of haze in the atmosphere would be to superpose a weakened general solar spectrum, showing no displacement of the lines because coming mainly from the center of the sun's disk, upon the spectra of the limb, where the observations for rotation are made. The blending of the lines from these two sources would have the effect of diminishing the measured displacements. Moreover, the effect would vary from line to line, according to the relative strength of the lines in the "haze spectrum" and the limb spectrum.

Stereoscopic Views of the Heavens.—Applications of the stereoscope in astronomy are now numerous and fruitful. A recent development in this line is the preparation of astronomical views for popular use in an ordinary stereoscope; two series of such pictures having been published by Prof. Max Wolf, of Heidelberg. The second series, issued last year, comprises 12 subjects, including comets, nebulæ, proper-motion stars, planets and satellites, the moon and the Milky Way. In these pictures the effect of perspective is, of course, an illusion, for the two pictures in each pair have, in general, merely been taken at different times, during which actual motion of the object has occurred. Thus two views of a proper-motion star were taken at an interval of 14 years. The result is that the star, viewed through the stereoscope, stands out beautifully between the observer and the stars constituting the background, though the proper-motion star is not necessarily any nearer, in fact, than the others. In some cases the appearance of perspective is hard to explain, as there has been no observable motion of the object. In one case, indeed, a pair of pictures of the Milky Way in Aquila were made from the same negative, yet the effect of distance is quite vivid. A long account of these somewhat mysterious pictures is published in the *Astrophysical Journal* by Prof. E. E. Barnard, who reports that he has borrowed Prof. Wolf's idea and prepared for the stereoscope two prints from an identical negative of Saturn, taken at Mount Wilson; the planet thus appears as a ball suspended in the middle of the rings in excellent relief. This subject is capable of further development.

Industrial Efficiency

Saving Waste Paper in England.—On account of the shortage of paper the saving of waste paper is now being carried on extensively and thoroughly in the city of Bradford, England. At the Bradford Town Hall, previous to the war, tons of waste paper had annually to be disposed of and at a cost of approximately $7.50 per ton; it is now being sold at prices ranging from $15 to $60 per ton according to the grade.

United States Now Makes Pyrometer Tubes.—A firm for which an installation for the manufacture of porcelain pyrometer tubes has been designed and supervised by the United States Bureau of Standards is now marketing these products, which are said to be at least equal in quality to the refractory porcelain formerly obtained only from a manufacturer in Berlin. The composition and process were worked out by the Bureau of Standards.

A Technical Library for German Industry.—According to a recent article in the *Frankfurter Zeitung* and an interview with a prominent librarian at Frankfort, plans are being considered for the establishment of a general technical library at Frankfort-on-Main, to be opened for public use. One of the leading city libraries has become interested in the project, and a beginning already has been made. It is said that the plan is unique among the cities of the German Empire, and an attempt will be made to furnish technical information which will be of value to the various industries.

Signs for Locomotive Controls.—The mechanical department of the Erie railroad is to be commended upon its adoption of caution signs for use in the cab of a locomotive for the protection of any person who may be working under or about the engine. These signs are made of jacket iron, 6½ by 7 inches in size, and have inscriptions that explain themselves. The plates are painted black and the letters are white, and are provided with spring clasps at the back so that they may readily be fastened on the throttle; while those for other levers are provided with a hole or other means for holding them in place.

Leather from Shark Skins.—The condition of the leather market makes desirable the utilization of all available supplies of suitable animal skins. The Bureau of Fisheries of the Department of Commerce has taken up the possible value of shark skins in making various kinds of leather. Such skins, as is well known, have for many years had a limited demand in the United States as coverings for minor articles of ornament and utility, but their use as leather has been very restricted. An acceptable leather has been prepared from shark skins in several foreign countries, and there is no apparent reason why the skins of certain sharks caught on our own coast or in foreign waters may not be converted into serviceable leather by American tanners.

Candle Light for Paris.—As a measure of war economy, a drastic lighting order has recently been announced in Paris. With a view to effecting a saving in coal and fuel, it is decreed that in future shops must not be lighted after 6 o'clock by gas, electricity, petroleum or alcohol. An exception is to be made in the case of shops dealing in foodstuffs, druggists, hairdressers and tobacco dealers. Shops are not compelled to close at 6 o'clock, but after this hour they must find other means of lighting such as candles or acetylene. The hours of lighting of theaters and other places of amusement are unaltered, but all such establishments will have to close one day a week. It is also contemplated that cafés and restaurants will close in future at 9:30 in the evening.

Fuel Economy in the Netherlands.—The difficulty since the war began of obtaining adequate supplies of coal for industrial uses in the Netherlands has led to various investigations and suggestions for the relief of the situation. A Dutch technical periodical describes a device for economizing fuel by getting all the coke and the unconsumed pieces of coal out of the ashes or refuse from a furnace and using them again. In many instances it has been found that more than 20 per cent, sometimes as high as 75 per cent, of furnace refuse consists of combustible material. The practice has been to pick this out by hand, but the results were not satisfactory. By the device described furnace refuse is ground and put through sieves, which separates it into parts of four different sizes. Each part is put into a separate basin containing a liquid with a specific gravity somewhat more than that of water, in which it is briskly stirred about. This liquid is said to be very cheap and easy to make and to be generally a refuse product of factories. The stirring and revolving of the particles in the liquid bring the lighter, which are the combustible remants, to the surface, while the heavier or unusable parts sink. The combustible remnants, therefore, need only to be scooped out, and when dried, it is claimed, make good fuel. It is stated that, in general, 2,000 tons of furnace refuse will yield 38 tons of fuel of good quality. The refuse left from the sieving process can be used in making a fine grade of beton, it is averred.

A Proposed Highway Tunnel Beneath the Hudson River

Two 17-foot Roadways To Relieve the Congestion on the River Ferries

THE system of ferriage between Manhattan Island and the mainland is one of the most important of the whole field of transportation. In some form or other it is as old as New York city itself, and, decade after decade, the ferry boats, steadily increasing in size and speed, have rendered good service to the community. Of late years, however, and particularly during the present era of the automobile and the motor truck, the Hudson River ferry boats, in spite of their size and the frequent schedule on which they are run, have reached the ultimate stage at which they are unequal to the demands of the situation. Passengers are well accommodated; but the delays to vehicular traffic, both horse-drawn and motor-driven, have become, in the case of some ferry lines, simply intolerable.

Early in the expert study of the problem it was recognised that there are two zones of traffic, one extending from the Battery to 23d Street, the other from 23d Street north. These demand separate consideration; and the conclusion has been reached that below 23d Street the passage of the Hudson should be made by tunnel and above that point by bridge.

A careful study of the problem was made by the engineering firm of Jacobs & Davies, who, it will be remembered, are the engineers who built the two tubes for the Pennsylvania Railroad and the four Hudson and Manhattan tubes. They obtained in the year 1913, either by actual count, or from official returns, statistics of wagon travel on the various ferries crossing the Hudson River, which showed that of a total vehicular traffic of 19,660 vehicles daily in both directions, not more than 2,000 per day used the ferries for the uptown districts north of 23d Street. It is in the downtown districts that the density of traffic for commercial vehicles reaches its maximum, the uptown ferries being used for the most part by pleasure vehicles.

Hence, these engineers, in their report to the New York State Bridge and Tunnel Commission, recommended, as a location for the downtown tunnels, a line from the foot of Canal Street, Manhattan, to intersect the shoreline of Jersey at approximately the extended line of 12th Street, Jersey City. The surface of the street would be reached at Henderson Street, which is the first continuous street, parallel to the river, connecting Jersey City and Hoboken. On the Manhattan side the tunnel would reach the surface on Canal Street, where the widening of the street for one block would be necessary.

The total length of the tunnels will be 8,350 feet and the surface of the roadway, at its lowest point, will be 89 feet below the surface of the Hudson River. The grade on the Manhattan side will be 3.7 per cent and this will extend to the lowest point of the tunnel, which will be near the Manhattan bulkhead line. At this point the grades below the river will be first 0.5 per cent and then 1 per cent. The rise to the surface on the Jersey side will be on a grade of 3.0 per cent.

The location would provide direct connection along Canal Street to Manhattan Bridge. It is in close proximity, also, to the Williamsburg and Brooklyn Bridges; to the new 1,000-foot steamship piers, and to the main arteries of travel to uptown Manhattan. On the New Jersey side this location gives immediate access, either to the low-level sections of Jersey City and Hoboken, or to Jersey City Heights by the viaduct.

There will be two separate tunnels, one for eastbound traffic and the other for westbound. Each will be provided with a roadway approximately 17 feet in width. In the opinion of the engineers, these tunnels would have a capacity of 5,000,000 vehicles per annum, which is not far short of the entire vehicular traffic now crossing the Hudson River by ferries. If it were found to be necessary, elevator shafts connecting with the tunnels would be placed at the waterfront, in addition to the inclined approaches extending inland.

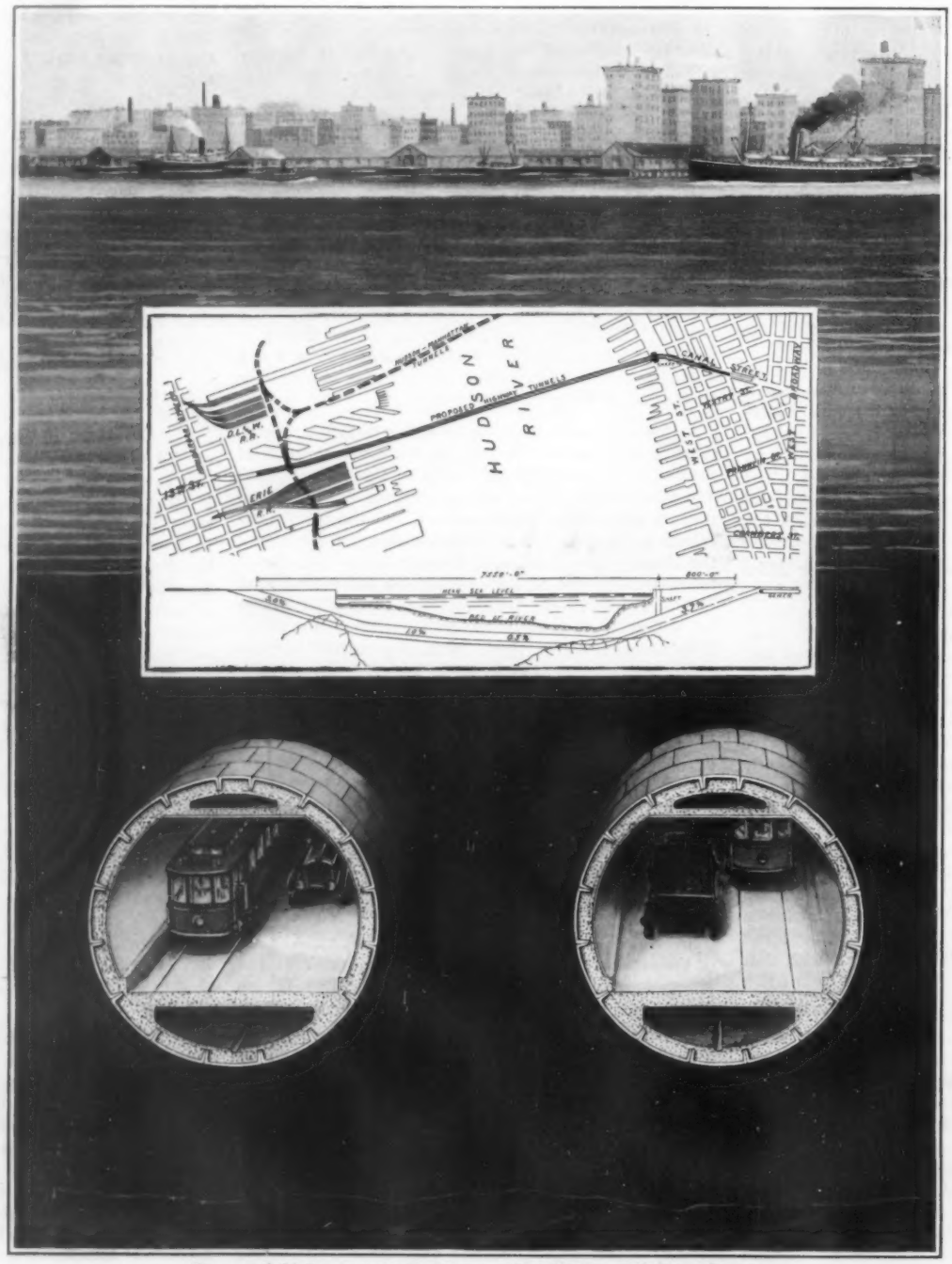
The engineers state that the construction of such tunnels is perfectly assured and thoroughly understood; since they would not differ, except in dimensions, from the six tunnels built by this firm for the Pennsylvania Railroad and the Hudson & Manhattan Railroad beneath the Hudson River.

Two tunnels of this character are in successful operation under the River Thames at London, namely, the Blackwall Tunnel, 6,200 feet long, and the Rotherhithe Tunnel, 6,883 feet long. Each of these consists of a single tube, providing for traffic in both directions in one tunnel, and in 1913 each tunnel accommodated almost exactly 1,000,000 vehicles, including automobiles. The Glasgow and Hamburg Tunnels have separate tubes for the traffic in each direction.

At first blush one would think that the sending of a line of heavy motor trucks through a tunnel over 8,000 feet long, each truck discharging its products of combustion into the tunnel, would so load up the atmosphere with poisonous gases as to threaten the lives of the users. The engineers, however, do not seem to have any particular anxiety on this score; for they point to the fact that none of the four tunnels above-mentioned is equipped with mechanical apparatus for ventilation; although provision was made in the Blackwell Tunnel to install such a plant if necessary.

In the proposed Hudson tunnels, as will be seen in our illustration, a ventilating duct of large capacity is provided beneath the roadway, with frequent openings leading to it. It is claimed that the gases of combustion, being heavier than the air, will settle to the floor and be drawn into the main ventilating conduit and so out of the tunnel. We think, however, that too much reliance must not be placed upon this theory of the descent of the gases, for the reason that the rush of vehicles through the tunnels will stir up these gases and mix them rather thoroughly with the pure air. In view of this consideration it would seem that only the provision of very powerful fans, or other sufficient ventilating devices, coupled with large and frequent openings into the ventilating conduit, would insure maintenence of the air at the necessary point of purity.

It is estimated that the time for construction will be about three years, an estimate which, in view of the fact that the two Pennsylvania Railroad tunnels were constructed in 18 months would seem to be sufficiently liberal.



Proposed highway tunnels between Manhattan and New Jersey

Potash in Prickly Pear

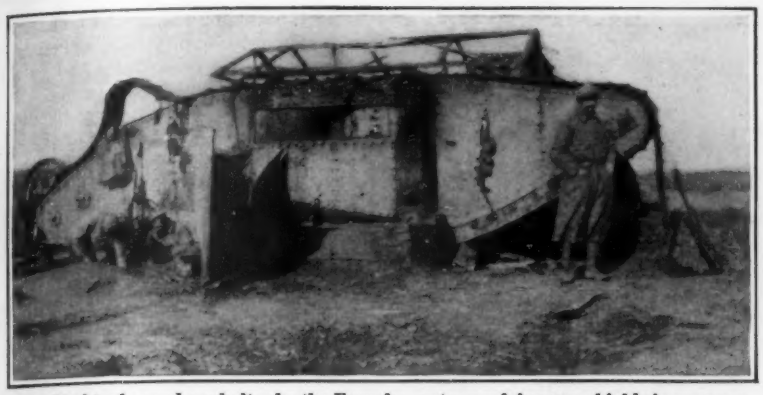
ARTICLES have recently appeared in some of the English journals to the effect that prickly pear, which has for a long time been a pest in Queensland, is now being turned to account as a source of potash. It is stated that the plant is killed on the Cactus Estates at Dulacca by spraying or gassing with arsenic trichloride, and that the ash from the burnt cactus contains 15 per cent of potash. Half a ton of 80 per cent potassium carbonate is said to have been obtained from five acres of the burnt cactus.

However, these figures may be for accuracy, the writer can vouch for the fact that the ash of the prickly pear contains a good proportion of potash. When in Mexico he had on several occasions to analyze samples of prickly pear, and noticed in the first place the high percentage of ash (4.87 per cent) produced on burning the plant, considering its juicy nature (84 per cent water). On analyzing the ash, it was found to contain 9.8 per cent of potassium oxide equal to 14.4 per cent potassium carbonate, which is very near the figure given above as contained in the Queensland cactus. This shows a yield of 0.7 per cent of potassium carbonate from the fresh green plant, or nearly 15½ pounds per ton.

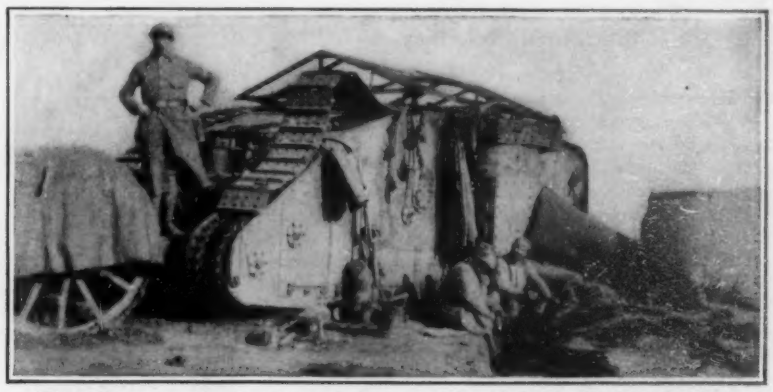
Considering the enormous quantities of prickly pear growing wild all the way from South America through Central America and Mexico, and into the United States, it would seem worth while to utilize this source of potash at the present time. Although the writer has no data on the subject, it seems to him very probable that other kinds of cactus, such as the órgano, candelabra, pitahaya, etc., also contain considerable amounts of potash.

The ash of the prickly pear also contains a small amount of phosphoric acid (1.5 per cent P_2O_5) and a large quantity of lime (44 per cent CaO). The latter is contained in the plant as oxalate, the crystals being easily seen in a section under the microscope.

A deduction to be drawn from the fact of the prickly pear containing so much potash is, that this plant must impoverish the soil in respect to this element of fertility, and that when land where much cactus is growing is cleared for wheat or other crops, it needs a dressing of some potash fertilizer or cactus ashes used instead.



Disabled tank, used as shelter by the French; note revolving gun shields in sponson



The tanks are smaller than is popularly supposed; this one is about 6 ft. by 24 ft.

A Tank in Trouble

THE British tanks, of which we have heard so much since they first crawled out to the attack in the Battle of the Somme, have been in action sufficiently long to test their endurance and verify, or otherwise, the claims for efficiency which were so freely made. Such evidence as the press has been permitted to make public, is not, of course, to be taken as conclusive. The Germans, very naturally, have pronounced them to be a failure. The British reports speak of them as a complete success. That we have not heard more about them lately may possibly be due to the fact that the extremely rainy weather of the late autumn turned the chalk formation of the Somme district into a greasy mud, and rendered difficult the operation of these weighty machines.

That the tanks are proof against injury by rifle and machine-gun fire can readily be understood now that photographs of them have come to hand—it is equally certain that they are vulnerable to the lightest field artillery; and such tanks as have been destroyed must have been put out of action by this means. These two photographs of a dismantled tank, show clearly some details which were lacking or obscure in former photographs. Thus the battery consists of four guns, carried two on each side, in a structure which, aboard ship, would be called a sponson. In this case it is a five-sided structure, built out from the side wall of the tank amidships, with two guns mounted behind revolving shields, one in each corner of the sponson. The structure extends far enough beyond the sides to enable the guns to fire parallel with the axis of the tank; so the crew can concentrate the fire of two guns in every direction.

It will be noted that the forward end of the machine rakes upward at an angle of about 30 degrees. This gives the caterpillar belt a good grip on the side of a shell hole and explains the ability of the tanks to climb out of deep depressions.

It will be noted that the right hand belt has parted, and, apparently, no means were at hand to make repairs; for as is clearly revealed in the picture, the tank has been dismantled and is being used as a shelter.

The Current Supplement

MANUFACTURING systems and factory management are matters of interest to everyone, either theoretically or practically, in these days of commercial preparedness. A valuable review of one of the most important components of the subject will be found in *Systems of Payment in Factories*, in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2141, for January 13th, 1917. *The Brazil Nut of Commerce* tells how these edible seeds are grown, and how they are gathered, several illustrations accompanying the text. *Making Bronze Statues* gives many interesting details of the various methods that have been employed in producing these attractive decorations and calls attention to the great antiquity of the art. A number of fine photographs illustrate some of the modern processes. The article on *Paleontology* tells us something of the aims and methods of a most valuable, but little understood branch of science. "*What is Hardness?*" discusses a subject of great scientific and practical importance, for which no satisfactory definition has yet been formulated. *Trees in Medicine* surveys a number of agencies by which nature has provided for the alleviation of disease. *Cyclonic Disturbances and Their Effect* attempts an explanation of the air currents involved in these ever recurring phenomena, and is accompanied by explanatory diagrams. *The Dynamographic Platform* describes a mechanism devised in France for teaching war cripples how to walk, and drawings show the construction of the device. *Refractory Materials* summarizes a discussion before the Faradan Society covering the characteristics, applications and methods of examination of an indispensable class of substances.

A type of portable electric lamp now being used in Mammoth Cave

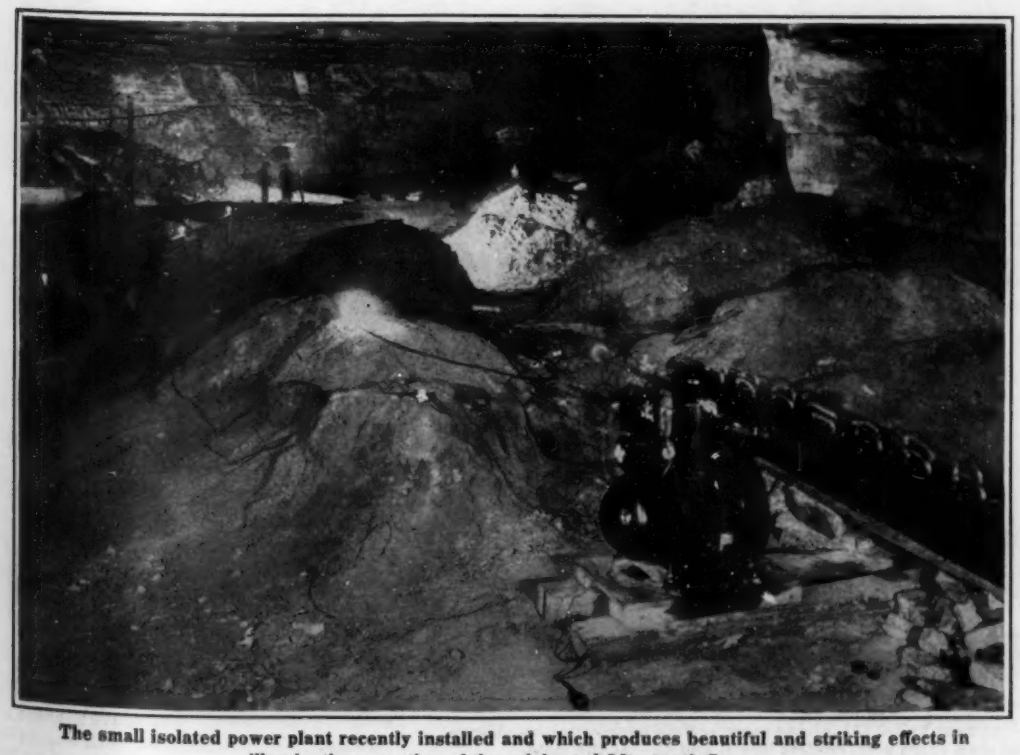
The Ninth Satellite of Jupiter

ACCORDING to Messrs. Nicholson and Shapley, the photographic magnitude of this latest discovered of the satellites is 18.6 at mean opposition. According to different assumptions as to its albedo, estimates of its diameter range from eleven to seventeen miles, making it probably somewhat larger than the tiny satellites of Mars.

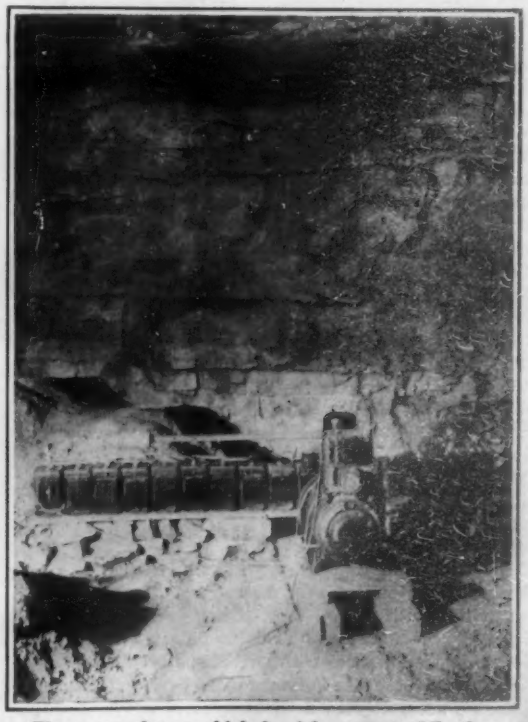
Electric Lights in Mammoth Cave

VISITORS to Mammoth Cave have always been able to get impressions aplenty of vastness and mystery, but with the dim, smoky lamps and torches of the guides serving as the only means of illumination, they have never gotten any very clear idea of just what the cave looks like. Of course the effect of mystery and vastness is a pleasing one, and deep uncanny shadows are not without their attractions; but in visiting such a natural wonder as this great cave, we should think that one would really prefer to get a clear view of the magnificent details.

This very thing has just been made possible by the installation of an electric lighting plant in a section of the cave. We illustrate the apparatus, which speaks for itself so far as mechanical details are concerned. It is said that the effect of the electric light on these stalagmites and stalactites is singularly beautiful, throwing them out in bold relief against the dark backgrounds of the cave in such a manner that guides who have worked in the cave for years declare that they are now seeing the cave for the first time. One can readily understand how the complete control which may be exercised over the beam of light makes it possible to add brilliant visibility without at all detracting from the existing charm of the cave's subterranean scenery.



The small isolated power plant recently installed and which produces beautiful and striking effects in illuminating a section of the celebrated Mammoth Cave



The accumulators which furnish current while the engine is standing idle

Simple Methods of Determining Rifle Muzzle Velocities

By A. L. Hodges

THE experimental muzzle velocity of a rifle is really the velocity several feet away from the muzzle, while the real velocity, and the one that is used in formulæ, is that taken at the muzzle. But so very close are the two that the resultant error is negligibly small.

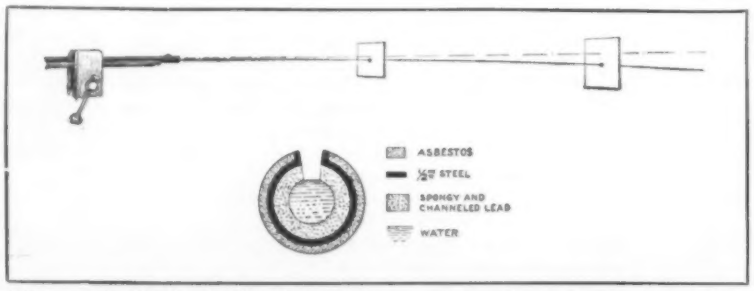
There are two classic ways of getting the muzzle velocity of a rifle and also two other ways. The latter have never been tried before as far as the author's knowledge extends. The two classical ways are the ballistic pendulum method and the electric screen method. The two new ways are the gravity method and the mechanical equivalent of heat method.

It was the writer's intention to perform the ballistic pendulum experiment method and the gravity method so as to determine which was the better; and he did so, although a certain error of adjustment, unforeseen, vitiated the gravity method result. However, a description of the four methods will serve to show the possibilities of each.

Arrangement of the pendulum in the determination of rifle bullet velocities

If a bullet be shot into a mass suspended so as to swing without rotation, the momentum formula holds good; that is to say, between inelastic bodies the total momentum before impact is equal to the total momentum after impact. If we have one body stationary, it has no momentum before impact. If the other body be caught in it at impact, the velocity of each after impact is the same.

Accordingly, if a bullet be shot into a pendulum made of wood, and if m stands for the mass of the bullet, M the mass of the wood, v the velocity of the bullet before impact, and V the common velocity of the contained bullet and pendulum after impact, we have the following formula: $mv = (M+m)V$. Then, as we can measure beforehand every term in this formula but v, we can solve for v. The factor v is measured indirectly of course as will be explained later, and there are certain errors which prevent us from announcing the result beyond two significant figures. This accounts for the marking of the present army rifle bullet at 2,700 feet per second instead of 2,700 and odd feet. For this particular bullet there may be an error also in the weighing of the powder behind different ones in the third place.



Above: Principle involved in determining muzzle velocity by the gravity method. Below: Sectional view of the pot used in the mechanical equivalent of heat method

The second method is to shoot a bullet through screens placed at certain distances apart, so that when the bullet hits a screen it makes an electrical contact which is registered on a chronometer—an accurate timepiece. If the screens are 100 feet apart, let us say, and the registering chronometer indicates that it took the bullet one twenty-seventh of a second to go that distance, we have the velocity of the bullet to equal 2,700 feet a second. But there are errors in a chronometer, especially to the fraction of a second; so that unless an enormous number of records have been taken for every part of the chronometer circuit and the average computed, this method allows of error. Further, the actual mark made on the rotating drum has dimensions which are comparable with the space between marks, thus another error is included.

The third method, that of gravity, depends upon the fact that a body shot horizontally will fall as fast as a body dropped straight—from a resting position—to the earth. Therefore, its vertical distance fallen would exactly equal that of a body dropping by gravity, which obeys the formula $s = gt^2$, in which s equals the vertical distance fallen, g the acceleration due to gravity and t the time taken. If we can get a gun exactly horitsonal and shoot it through a target a certain distance away, all we have to do is to get the difference in level between the muzzle of the gun and the hole the bullet makes in the target. This, then, is s. Knowing g we may solve for t. This t is also, of course, the time taken for the bullet to traverse the horizontal distance between the muzzle of the gun and the target. Suppose t came out one twenty-seventh of a second and the horizontal distance gone in that time was 100 feet. We would get 2,700 feet as the velocity of the bullet. Let us see, though, if we could not get things to a greater degree of accuracy than two places. The horizontal distance can be measured very accurately with a steel tape, to within a tenth of a foot at least. This would put four significant figures with anything over a hundred feet. The surveyor's level can measure accurately to a thousandth of a foot. A fall of over a tenth of a foot would then have three significant figures, and a fall of over a foot would have four. The remaining thing to investigate is the degree of accuracy with which we may level a gun barrel. With care, it is obvious that this can be done as well as in the instance of the surveyor's level. So the result should appear with three significant figures and possibly four—something that has never been done yet, as far as the present writer's knowledge extends.

The fourth method is that of the mechanical equivalent of heat. If a moving body is absolutely stopped by a body at rest, and if both bodies remain at rest after impact, the entire energy of the moving body is converted into heat. As the mechanical equivalent of heat has been determined to four significant figures, and as the mass of a body can be determined to four places if it is of any mass at all of practical use, and as the temperature of a liquid may be determined to a hundredth of a degree fairly well, this method should be of value. Suppose we have a steel calorimeter with a very small radiation constant—a steel pot of a half inch thickness enclosed within an asbestoes framework would serve. Line the pot inside with a 2-inch sheet of lead having pores through which water could circulate. Now fill the pot with water and measure the common temperature of the whole thing. Then take an army rifle and shoot rapidly a clip of cartridges into the lead mass. After stirring the water thoroughly, measure the temperature. As the specific heat of iron and of lead are known, as the mass of the pot and of its lining and of the bullet are known, and since the temperature may be measured, we would have an equation which would finally lead us to the velocity with which the bullets were shot. It would be as follows: Letting M be the mass of the iron pot and a its specific heat, m the mass of the total lead (including the weight of the bullets and the lead lining) and b the specific heat of lead, and n the mass of the coatings of the bullets, and c the specific heat of the same, and t the difference in temperature before and after firing, and O the mass of water, we would have for the total number of calories of heat generated, symbol $H = Ot + Mat + mbt + nct$. Now we know, naturally, that the total kinetic energy which was transforned into heat is equal to—in case the number of bullets shot was five—$5/2\ mv^2$, if m = mass of one bullet and v its velocity. So then, the mechanical equivalent of heat being known, we have an equation all of whose terms have been measured but one, and that one being v. For $5/2\ mv^2 = K\ (Ot + Mat + mbt + nct)$, K being the mechanical equivalent of heat.

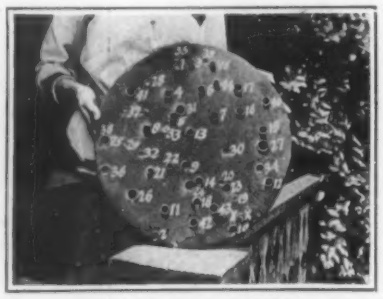
In the actual experiment with the ballistic pendulum performed in the laboratory by the writer, the wires were 233 cm. long, and the pendulum was a cylindrical core obtained from a veneering works and weighing 47 pounds. The bullet, having to be shot into the block horizontally, presented some difficulties. A steel wire was stretched above the block but in the same vertical plane as its axis, to the opposite wall. Another steel wire was run under this from the center of the end of the block and made as near horizontal as possible. This latter wire was run through the barrel of the rifle held in a wooden vise. The resulting velocity of the pendulum and contained bullet was not measured directly, but simply the chord of the arc through which the pendulum was thrown, was measured. Two ways were provided to measure this chord. A string which would pull out but would not go back was attached to the pendulum. Subsequently, an experimenter could pull the pendulum out to the end of the string and measure the arc chord at leisure. Also a camera was set to take a time exposure of the pendulum under a mercury arc lamp, the idea being that the blur made on the negative against a scale set up behind the pendulum would show accurately where it stopped, its stopping point to make the biggest effect on the negative on account of length of time in one place. However,

(Concluded on page 70)

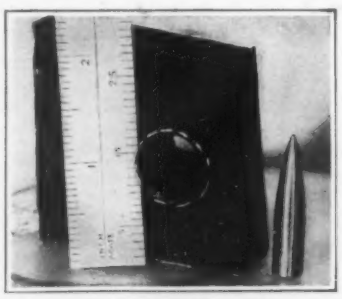
What the French Helmet Will Stand

By Edward C. Crossman

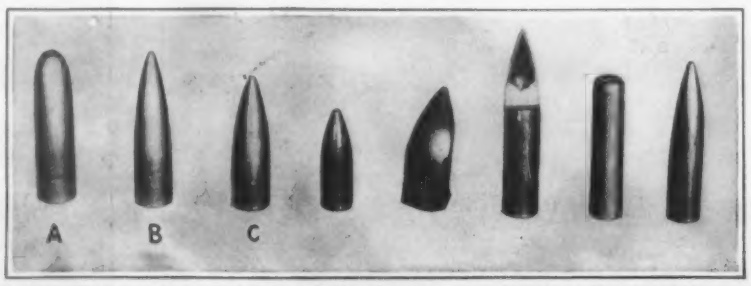
IN the first year of the war, when the queer cap of the French poilu continued to grace his sunny brow instead of the present steel pot, a couple of quiet and business-like strangers appeared at the testing station of a huge American corporation making explosives, and asked if anyone there could test for them the bullet-resisting qualities of a steel helmet they had with them. The obliging assistant to the man in charge volunteered to do the testing. Trotting out a New Springfield, the American service rifle, and setting up the experimental helmet at a distance of 80 yards, he shot a neat round hole in the steel, through and through. The strangers smiled, thanked him, gathered up the perforated helmet and departed, first asking permission again to submit a helmet or so to his rifle. A few days later they returned with another helmet, and the assistant shot a hole in this one, likewise.



Half-inch steel plate after penetration tests



Block of ¾-inch steel and a .28 bullet like the one that hit it



The old type blunt nose bullet (A), giving more certain penetration on oblique surfaces than sharp point bullets like B and C. At the right, various types after impact

The strangers knew nothing about rifles or the effect thereof, they even expressed their surprise at the ability of the powder man to hit the helmet at such a distance.

But a third, and a fourth, and a fifth time they put in their appearance at the plant. By that time the powder man knew they were officials of a Philadelphia steel company of old and established reputation. Each time the brown service rifle obligingly shot a neat round deckle-edge hole in the helmet and each time the visitors gathered up the steel pot and went their way.

Finally there came a helmet that merely dented where the bullet struck it. Two shots had to land in the same spot to get through. It may be explained that the service rifle of our Government has a striking energy of 2430 foot-pounds, and a muzzle velocity of 2700 feet per second, with a bullet in sharp point form weighing 150 grains. The next helmet—still of the light-weight steel necessary to keep the affair from telescoping the poor soldier's neck—refused to let the service bullet through. The powder man, with a quiet

(Concluded on page 70)

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

The Automobilist's Dream

To the Editor of the SCIENTIFIC AMERICAN:

We automoblists follow the jousts between the gas- and steam-engine men with a great deal of interest and amusement—but many of us are convinced that the ultimate solution of the problem of locomotion is to be found neither in internal combustion nor steam engines, but in electricity.

With the electric motor, the engineers have gone nearly the whole distance in mechanics in giving us a nearly ideal efficiency. The problem that remains is one of chemistry; and there are many of us who are sitting back awaiting the advent of some bright young man from the research laboratory to tell us the ingredients of the primary battery of the future—a battery in which the electrodes are to be permanent, and the energy is to be derived from the chemical action of the electrolyte itself. When he emerges, he will have a device so simple that the drug store will be our charging station; he may be able to patent it, but he won't be able to restrict its use—so we motorists will be glad to chip in and provide for his declining years. When he arrives, we will be able to buy the stuff by the barrel or by the ounce; or, if it is going to be a gas proposition, we will stop at the wayside station and buy not so many gallons of gasoline, but so many atmospheres of oxygen or hydrogen, or whatever it is to be.

They tell us there is enough energy in a pinch of radium to reverse the hydraulic engines of Niagara. Electric energy is developed in the reaction of chemical salts upon each other; every compound, every element, in fact, contains the potential energy of a coiled spring. When the bright young man comes out of the laboratory with the secret of how to upset the ratchet of this spring, on that day we will cease to worry about geological survey reports on the available supply of coal and crudes. Also on that day we will throw away all the superstructure of our cars except the springs and upholstery; and we will mount the remnant on a pair of axles, one of which—front or rear—will consist of the elongated halves of a self-differentiating electric motor. We will throw away radiators, magnetos, timers, gear-shifting appliances that never grow up, smells, mean-effective-pressures, clutches founded on the doctrine of coefficient-of-friction, the volumetric and thermal efficiency twins—all the ills, in fact, that a motorist carries around with him now as sprung weight—except punctures, which we will always have with us so long as we ride on air.

When this day comes all we will have to carry, besides the motor and steering wheel, will be an electrolytic tank with permanent electrodes, in which properly controlled gases may resolve themselves into compounds; or possibly it will be necessary only to spray water into vat filled with drug-store chemicals, to evolve electrical energy as we now evolve acetylene from carbide.

This isn't an impossible dream; modern science is heading in this direction, and I believe most of us now on earth will live to see its fulfillment. How much electrical energy is required to decompose a litre of water? How much of this energy can be recovered in resolution? Can these two gases, oxygen and hydrogen, stored under pressure by laboratory methods, be made to combine, with electricity as a by-product? If so, how many coulombs of electricity are to be derived from one cubic inch of gases under the highest practical compression? If we could throw away the highly inefficient and numerous details of our gasoline and steam engines—which return to us in useful work about five cents out of every dollar we spend for fuel—we would have plenty of room to house gas bottles in our cars.

If I were Andrew Carnegie and still desired to die poor I would endow research in this direction. In conclusion I may state that I am a writer of fiction by profession, and given to flights of fancy.

FREDERICK IRVING ANDERSON.

New York.

A Proposed Orphan Naval School

To the Editor of the SCIENTIFIC AMERICAN:

The increased building program of our Navy is such that it has been necessary for the last Congress to pass a measure which authorized and made increase for 26,000 men in its personnel, of which there have been obtained, up to the date of this writing, but 2,524. This is a serious problem and with the marked increase in our naval building program it becomes more serious.

It would be well for Congress to take this matter into consideration before making further increases in the Naval Building Program. What is the use of spending money for ships if we cannot get men to man them? The future Congresses as well as the present one, will be confronted with the same condition. and if this is true, then why not, in solving the problem, adopt one which would, in conjunction with our present recruiting system, furnish an adequate future supply of men for the Navy. The writer suggests the following for consideration:

Congress could make provision for two or three orphan Naval schools, which could be situated in different parts of the country and in which orphans and homeless children could be placed to be educated, and trained while there for our Navy. When they have attained the age of eighteen, each boy would be ready for service, also he could have learned some trade, and when he should have served a certain time in the navy, say five years, he would be eligible to be placed on the reserve list. The environments of such a school would be excellent and would doubtless fit many men for good citizenship who would otherwise be deprived of such advantages. I know of no better way in which money could be spent, and at the same time the government would be well repaid.

WM. H. MCCULLOUGH.

Those Guarantees for Permanent Peace

To the Editor of the SCIENTIFIC AMERICAN:

Both parties to the present World War claim they are fighting to obtain "Guarantees for Permanent Peace."

When President Wilson invites the neutral nations to a conference a first aid would be a precise definition of what "Guarantees" are expected or possible. Solemn treaties are mere paper; "sitting on bayonets" over conquered territory breeds passion for revenge; crushing cash indemnities keep alive that passion.

These all have been tried and failed! Has any other method succeeded?

Yes! Succeeded conspicuously. Just over a century ago the Treaty of Ghent, the laughing stock of contemporary diplomats, closed the war of 1812 to 1814 between this country and Great Britain. No word was therein of any cash indemnity, of any cession of territory, or what the war was about; nothing to humiliate either party; nothing to leave a sting to rankle and breed more war.

So far good! President Monroe went further. He found the way to make peace permanent. On April 28, 1818, he proclaimed to this nation the signing of the "Rush-Bagot arrangement" by which a mutual disarmament was effected on our 4000 miles of northern boundary. No warships whatever were to sail the Great Lakes and, by a further "tacit understanding," no additional forts and garrisons to be placed on the border.

What happened after the diplomats laughed?

"He laughs best who laughs last!" The dove of peace settled on that long line and has barely ruffled its silver wings in a century.

"Where nobody's loaded nothing explodes!"

And now the whole borderland laughs in limitless peace and prosperity under the only possible real guarantee of permanent peace—disarmament.

What America can do, why not Europe?

EDWARD BERWICK.

Pacific Grove, Cal.

A Criticism of Our New Battle-cruisers

To the Editor of the SCIENTIFIC AMERICAN:

Considerable adverse comment on the battle-cruiser, as a type of warship, has been made of late, but nothing seems to have been said concerning the design of the new American battle-cruisers. Perhaps this is due to the fact that so little is known. If reports are true, however, I believe that certain criticism of this design would not be out of place.

A recent issue of the *Army and Navy Journal* gives the following specifications for the new cruisers: 35,000 tons, 35 knots, ten 14-inch guns, 8-inch belt. It would seem from this that the American designers have produced an exaggerated British "Lion" class, with greater gun-power and speed but less side armor. I doubt very much, though, if the behavior of these ships in the present war justifies the United States in following the British design.

In the battle of the Dogger Bank the "Lion" was so badly crippled she had to be towed to port. If the circumstances of the battle had been reversed, as they were at a later date, the "Lion" would have been captured or destroyed.

The only phase of the Jutland battle that is absolutely clear and which both sides agree upon was the engagement between the opposing battle-cruisers during the first hour. Five German battle-cruisers fought six British battle-cruisers supported by four fast battleships. The English had a great preponderance in gun-power, firing opened at 18,000 yards, the weather was clear at this time and the sun was behind them. One would expect the fighting to have resulted in favor of the English but what actually happened was quite the reverse; the Germans sank two British battle-cruisers ("Indefatigable" and "Queen Mary") by gun fire, without any corresponding loss to themselves.

It does not materially alter the case of British superiority in gun-power, whether the "Hindenburg" or the "Von der Tann" be included in the German division, as the English state that there were no surprises in the shape of 16-inch or 17-inch guns in the German fleet.

All the above may be found in the back of the Proceedings of the United States Naval Institute for July-August and September-October.

If it had not been for the support of the four ships of the "Queen Elizabeth" class, the British cruisers would probably have been driven back upon their battle fleet without ever discovering the German main fleet. But why this apparent British inferiority when they had so much to their advantage? While it may have been due to better shooting on the German side, I am inclined to believe that it was primarily on account of inadequate armor protection in the English ships.

On the other hand the German battle-cruisers appear to have been in the thick of the entire battle and to have withstood a most severe pounding from 12-inch, 13.5-inch and 15-inch guns.

Therefore, it would seem to be folly on the part of the United States to exaggerate the traits of these British cruisers in our own ships. The purpose of any type of warship must be, first of all, to meet successfully enemy ships of its own type. If our battle-cruisers cannot meet the battle-cruisers of a possible enemy, they are of little more use than ordinary scouts.

I believe a more conservative design would give us a far more satisfactory ship—a ship fast enough for all practical purposes but possessing sufficient armor to meet the battle-cruisers of an enemy or to stand in the line of battle when necessary. A ship of 35,000 tons could possess all the offensive and defensive qualities of the "Queen Elizabeth" and still attain several knots more speed.

It may be presuming a good deal for a layman to attempt to criticise the experts in our Navy, but it must be remembered, too, that these same men have made mistakes in the past and may do so again. The three cruisers of the "St. Louis" class (copies of the British County class) have never been considered of much value. Again, I believe that most naval men now regret that the 13-inch gun was ever discarded for the 12-inch gun in the "Maine" and subsequent battleships.

I would be very glad to see your magazine publish an article dealing with this subject fully, especially if it should prove my theory to be incorrect.

A. B. DICKINSON.

Oakland, Cal.

Draining the Everglades—A Retraction

In its issue of September 16th last the SCIENTIFIC AMERICAN carried a long article describing the dredging and draining operations now under way in Florida. Several correspondents have complained that this article is so written as to give an altogether false impression of the status of this work, and after investigation the Editor finds this to be the case.

The reclaiming of certain parts of the Everglades is actually under way; and in his description of the mechanical means employed our contributor was entirely accurate. It is in his discussion of the present and future scope of the work that this contributor is guilty of misrepresentation. Where he states that within a year the whole of the Everglades will be drained and open to settlement, the state officer in charge of the work as chief drainage engineer informs the SCIENTIFIC AMERICAN, over his signature, that the canals now under way are not planned to drain the entire area and are not capable of so doing; that "the drainage of two-thirds of the Everglades has scarcely yet been undertaken"; and that some portions of the drainage district "must wait several years before drainage will have been accomplished." He backs these statements with such an imposing array of figures that there can be no doubt as to his warrant in making them.

"At the present time there is a strip of land about six miles wide bordering the south shore of Lake Okeechobee which is dry and ready for cultivation; on this area are located many farms and truck gardens. On the lower reaches of the North New River, South New River and Miami canals there is also an area interspersed with farms, but which has not yet received sufficient protection against an overflow entirely to eliminate floods during heavy rainy seasons."

This, quoted from the chief drainage engineer, the Editor is sure represents fairly the present state of the Florida Everglades reclamation project. It will be readily understood that while the Editor makes every reasonable effort to check up his contributors, it is not always possible to guard against inaccurate statements from a seemingly authoritative source. This writer had access to all the avenues of information; in particular he was provided by the state engineers with reports, pamphlets, statements, charts, etc. Consequently it seemed to the Editor reasonable to assume that his treatment was to be trusted. That this turned out not to be the case, and that the readers of the SCIENTIFIC AMERICAN were misled, is a source of great regret to the Editor; and he extends his sincerest thanks to the correspondents who directed his attention to the imposition.

A "soft fitter" at work on a machine gun, using wooden wrench

Machine Guns by the Thousands

How a Gigantic Industry was Conceived, Planned and Realized in Less Than a Year's Time

By Austin C. Lescarboura

SO OFTEN does the question of our military preparedness arise in these troubled times that any topic bearing on our ability to make war, either in an offensive or defensive rôle, must be of immediate and general interest. Lacking, as we do, the requisite number of trained soldiers ready to take the field at a moment's notice, our greatest reliance, while present conditions obtain, must obviously be placed on superior—nay, preponderant—equipment. Would we be able to furnish our present forces with this preponderant equipment at short notice? Perhaps the answer is to be found in the story that follows; a story, by the way, that reflects a degree of initiative that is typically American.

—THE EDITOR.

The finished gun barrel at the left and the stock at the right

OCCASIONALLY someone accomplishes the "impossible," to the astonishment of the entire world which has been playing the part of an interested but pessimistic spectator. Strikingly typical of "impossible" things made possible is the story of how a group of American business men, appreciating the importance of the machine gun in modern warfare and foreseeing the coming big demand for this class of weapon, conceived a giant industry devoted entirely to the manufacture of machine guns. Not to be daunted by the numerous industrial problems involved, which were made all the more difficult by the abnormal industrial conditions obtaining during the year just elapsed, these men have worked out their plans to a signally successful consummation in less than a year's time to the accompaniment of the chorus "It can't be done," from all sides.

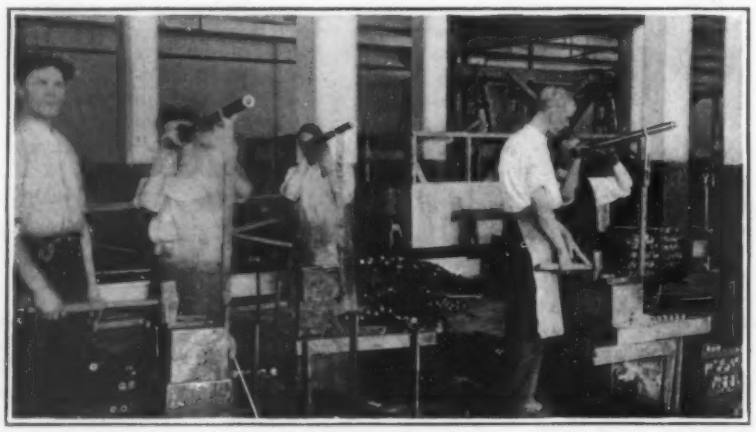
Toward the close of 1915 a group of men, headed by Mr. A. F. Rockwell of Bristol, Conn., a well-known industrial leader of New England, announced their plans for the organization of a machine gun industry on an unprecedented scale. Casting about for a type of gun that they could manufacture, the decision was made in favor of the Colt automatic gun, which has been the weapon of the United States Army and Navy for years past. Arrangements were soon concluded with the proprietors of the Colt automatic gun patents, whereby the new organization was authorized to manufacture this type of weapon under royalty.

Turning then to the production end of their project, the group decided on the expedient of purchasing the works of a manufacturer whose guns have been famous for a half century, not so much for the material side of the plant thus secured as for the prestige attached to the name thus acquired. For even with the magnificent equipment of the plant the facilities were absolutely inadequate for the quantity production of a firearm as intricate and painstaking to make as the machine gun. And then there still remained that cardinal, but too often ignored, factor in big industrial undertakings—the personnel.

About the first of the past year the plans of the little group were well under way. Then it was that a number of skilled mechanics were assembled and brought into consultation with regard to the manufacture of the Colt gun. Although many of these men were gunsmiths by trade, with but one or two exceptions they confessed that they had never seen a machine gun, much less attempted to make one. However, they had absolute confidence in their ability to undertake the task successfully. The blue-prints—their sole guide—were gone over carefully so as to acquaint themselves with the product planned; and then each man was assigned some particular part.

Having familiarized himself with the part he was responsible for, as well as its relation to the other components of the gun, each man was assigned to a machine shop in one of the various cities of New England, and there had at his disposal the best workmen available. His duty was to prepare the jigs, tools, fixtures and gages for the parts and operations that the works manager had assigned and laid out for him, and he was impressed with the fact that time-saving was the prime essential.

Meanwhile there was being erected in record time a new factory building in the heart of New Haven. Machinery was purchased and installed, notwithstanding the fact that machinery of all kinds was at a premium and difficult to secure in the numbers required for an entire plant.



"Rough straightening" of the machine gun barrels, using a sledge hammer and anvil

There followed the return of the master mechanics to the home plant, bringing with them the completed tools, jigs, fixtures and gages, along with the best workmen from the shops where the preliminary work had been conducted. With some seventy-five high-priced men as the nucleus of the personnel forces, the country was scoured for mechanics until the present total of about 2,400 employees was attained.

At the same time there was the problem of securing the necessary materials. We are all more or less familiar with the huge demands that are being made on our steel mills, hence can appreciate what it meant to be charged with the ordering of the tremendous quantities of steel required for the hungry machines of the new plant. In reply to their inquiries the machine gun makers were told that deliveries could be made post haste—anywhere from six to nine months' time. Even the offer of a substantial bonus for immediate delivery of the much needed supplies was of no avail. It was then that there entered into the transaction that factor that so often creeps into big business deals at unexpected moments—personality. Someone in the new organization knew someone in the steel industry; the requisite supplies soon after appeared at the plant in the necessary quantities.

Despite a delay of two and a half to three months, due to the indecision of the Russians in charge of the initial machine gun contracts placed with the new organization, by April 29th the plant had ten guns finished. The most critical requirements and the severe inspection of the Russians were met successfully. Then the quantity production methods were gotten under way, with the most improved machinery and with a personnel keyed up to the highest pitch engendered by high wages, bonuses, good fellowship and welfare work. By leaps and bounds the production rose to 160 guns per day, followed shortly afterward by the present output of 200 complete and perfect guns per day.

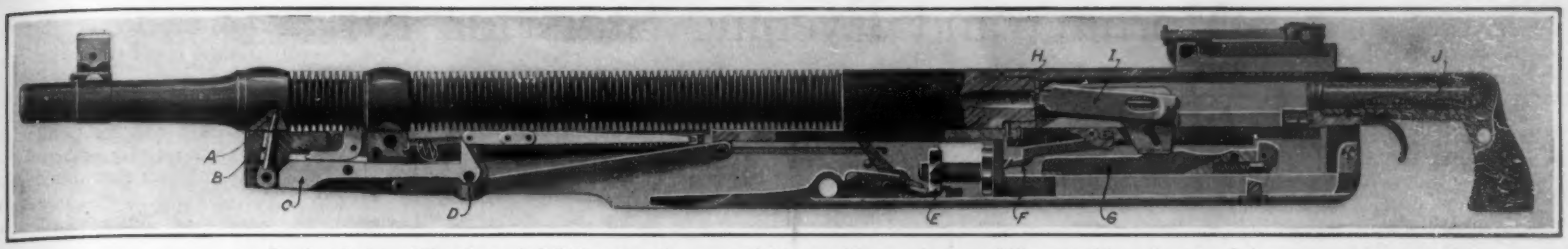
The Colt Automatic Gun and How It Functions

The gun which the new organization is producing at present is known as the Colt-Marlin, following closely the general design of the Colt automatic. It is an air-cooled gun, and depends for its operation upon the escape of a small portion of the gases of explosion through a port, a short distance from the muzzle. By referring to the accompanying sectional view it will be noted that the moment the bullet passes the port *A* the previously confined gases pass into the port and act upon the piston *B*, which is pivoted to the end of the bell-crank lever *C*. The piston receives a sharp impulse from the gases coming through the port, and this in turn is imparted to the lever which is swung downward and backward through a considerable arc. It is this rotary, or partly rotary, movement that is converted into a reciprocating movement at *D*, and which serves to operate a train of levers, rods, springs and a feed wheel, all working in harmony in the functioning of the gun mechanism. Thus the cartridges, held in the tiny pockets of the woven canvas belt, are fed into the maw of the gun by the turning of the feed wheel *E*; each cartridge as it comes into position is plucked out of the belt by the cartridge extractor *F*, delivered to the carrier *G*, which in turn raises it to the chamber position; then the bolt *I* is brought into position, closing the cartridge chamber, and the gun is ready to fire. If the trigger is pulled back or held back, the piston hammer *J* is thrown forward through the agency of the spring in back of it, hitting the pin running through the bolt, which in turn explodes the cartridge. Ejection of the spent cartridge

Empty cartridge cases—the remains of three days' testing of machine guns

Machine gun belts, each with 250 rounds

The Colt-Marlin machine gun and tripod as furnished to the Russian government



Sectional view of the air-cooled Colt automatic gun, which is used by our Army and Navy, and by other countries

is then effected by the ejector, which projects into the path of the fired case; and the cycle of operation is repeated with a fresh cartridge.

The first cartridge of every belt must be brought into position manually; that is to say, after the brass end piece of the belt has been inserted in the gun mechanism, the bell-crank lever in front of the gun must be pulled down once, resulting in bringing the first cartridge into the firing position. The gun is then ready for intermittent or constant firing, and as long as the trigger is pulled back it will fire at the rate of 450 to 500 rounds per minute until the ammunition is exhausted. The operation of the gun is entirely automatic.

The cartridges are loaded into the belt by means of a simple loading machine. The cartridges are received in cardboard containers, ten cartridges in a row, two rows to each container. With two sweeps of his hand the operator places the 20 cartridges in the feed slot of the loader, and as the handle is turned the cartridges are placed in the belt in exactly the right position. So snugly do the cartridges fit in the belt pockets that their accidental falling out is precluded. Each belt holds 250 rounds; and numerals in multiples of 25 are stenciled at intervals to indicate at a glance the number of rounds already fired. The belts can be used over and over again.

Machine gun belts are speedily loaded by means of belt-loading machines

The completed machine guns are inspected and stamped by these Russian officials

Machine Guns in the Making

It is in a long room in which thousands of machines and flapping belts blend together in creating in the visitor's mind the atmosphere of the jungle, with a small army of men bending over the mysterious automatic machines that function with almost human dexterity, that the parts of the machine guns are made. Even a superficial study of each part in the making discloses the fact that the preliminary work of the works manager has indeed borne its fruit; for at every turn one is surprised at the amazing ingenuity shown in simplifying different operations on the one hand, grouping a number of operations on one machine on the other hand, and making a better product through better methods, generally. Whereas a certain part, following the usual method, would require five operations, it is here made in one operation.

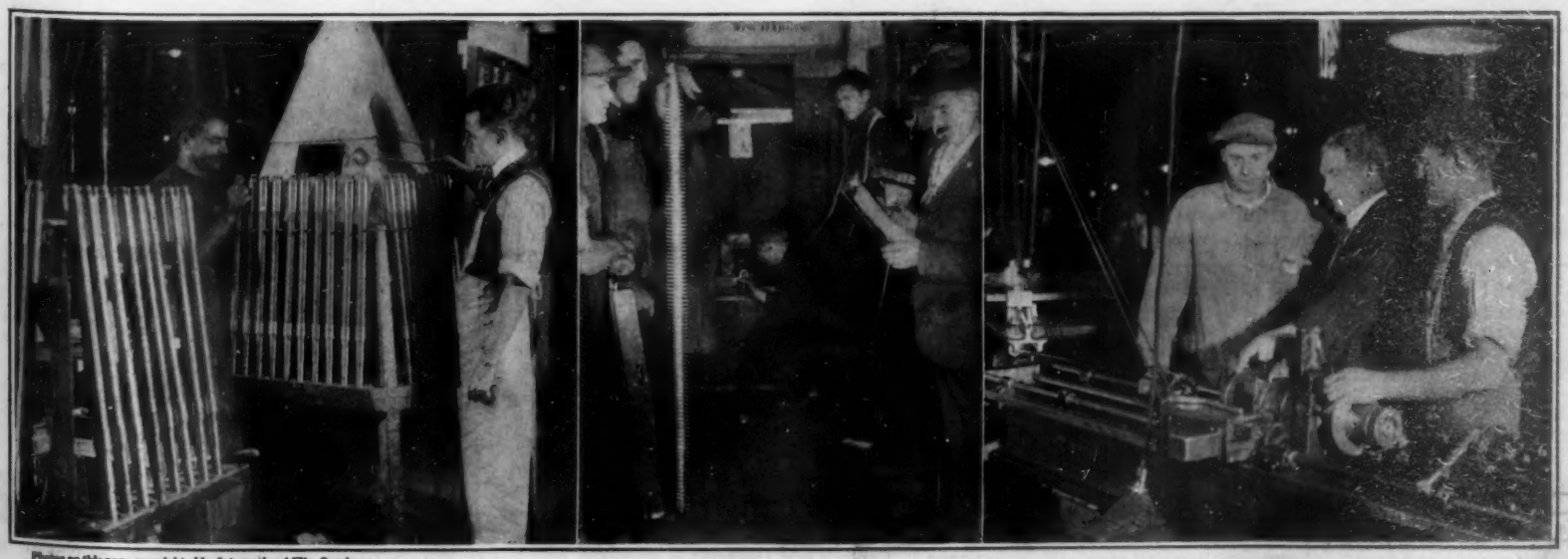
The manufacture of the machine gun barrel is typical of the time- and labor-saving methods employed. The stock comes in lengths of 22 feet, 1¾ inches in diameter, and of the hardest steel. It is cut into 28½-inch lengths which weigh 19 pounds in the rough as compared with 8 pounds in the finished product, which fact offers some idea of the amount of metal that must be cut away in the machining processes. In all, 73 operations are required for this one part, among which may be mentioned the boring of the barrel by means of a single-fluted drill several feet long, which remains stationary while the stock rotates. A stream of oil passes through a hole in the drill to the single cutting edge, keeping it cool and clearing away the chips of steel as the drill advances through the solid bar. Later, the bore is reamed out, followed by the rifling operation. In this instance the barrel is rigidly clamped in the fixture and the long, hollow tube containing the cutter is drawn through it while the cutter end slowly revolves as it passes through the bore. This gives the "twist of rifling" that causes the bullet to spin on its axis as it leaves the barrel, and to keep "point-on" during its flight toward the target. The rifling cutter takes but a small chip at each stroke, and at the end of the stroke the barrel is revolved one-fourth of a turn so that the next stroke is in a new place. After cutting four of these spiral grooves the cutter is again cutting in the first groove, and the operation is repeated until all the grooves have been cut to a depth of about .0065 of an inch—about twice the depth of the rifling in the ordinary hunting rifles.

An interesting phase, too, is the truing of the barrels. The transportation and handling of the raw stock and the machining operations usually leave the barrel somewhat warped—warped in the sense of a fraction of a thousandth part of an inch, but warped nevertheless in the sense of firearm accuracy. Four times the bore of each barrel is inspected and straightened The first and second straightening operations are undertaken with a sledge hammer and an anvil, and are termed "rough straightening," while the third and fourth are of a more delicate nature and call for the use of special machines capable of exerting tremendous pressures at the required points. The barrels are tested by looking through them and detecting the shadows caused by slight departures from absolute straightness.

Another feature of interest is the making of sulfur-wax casts or molds in the chamber of each gun barrel, in order to examine the condition of the chamber. A small plug is inserted in the barrel just below the chamber and a liquid mixture is poured into the chamber. This solidifies quickly, without shrinking, and being readily removed it shows exactly the size and condition of the chamber. If there are any scratches or imperfections in the chamber, no matter how slight they may be, they are immediately detected by the impression in the sulfur-wax mold.

The cutting of the grooves on the outside of the barrel, giving birth to the air-cooling vanes or flanges, is accomplished on one machine in five operations. Fifteen grooves are cut at a time. The machining and finishing of the outside of the barrel are carried out on a variety of lathes and grinders, the barrels progressing from one machine to the next with a precision suggestive of clockwork.

(*Continued on page 69*)



Photos on this page copyrighted by International Film Service

Making sulfur-wax molds of the barrel chambers

One of the firing booths, showing a gun undergoing the test

Rifling machine at work on a machine gun barrel

Morning and Evening Stars for 1917

By Frederic R. Honey, Ph. B., Trinity College

IN preparing this article each year with an effort to give some account of the solar system, the writer is confronted with the problem of selection from the great store of material which the planetary system offers, and thus to bring the illustrations within the limits of these pages. Obviously the treatment of any one of the topics here mentioned might be expanded almost indefinitely; but the motive in this paper is merely to enable the student, by use of the plots, to determine the morning and evening stars for any day in the year, and to become familiar with the solar system as a whole.

The Earth and the Sun

The bodies first in ordea of observation are plainly the earth and the sun—our moving observatory and the center of our system.

The observer of the heavens usually has difficulty in realizing his position in space, as the earth rotates on its axis in 24 sidereal hours. This is due to the continually changing position of his zenith and horizon illustrated in Figs. 1 and 2, which represent the earth at the dates of the summer and winter solstices, the observer's latitude being that of New York city. Since the earth's axis, which is inclined at an angle of 66° 55′ to the ecliptic, moves into parallel positions, it is evident from the figures that the sun's latitude at noon in Fig. 1 is represented by the angle α, and that this angle gradually diminishes in the interval between the dates of the solstices, until it reaches its minimum value β shown in Fig. 2, when, six months later, the sun is seen in the opposite direction. It should be noted also that a planet crosses the meridian at midnight at a low altitude when the date is at or near that of the summer solstice; and at a high altitude when it is at or near that of the winter solstice.

At a velocity of 18½ miles per second our planet moves a distance of nearly one million six hundred thousand miles each day, which subtends at the sun an angle on the average of nearly 1°. The distance from the earth to the sun in January is more than three million miles less than in July. The mean distance is 92,897,416 miles, and the diminution and increase are due to the eccentricity, which is represented by e in the plot of the earth's orbit. The distance from the center c to the sun is equal to one-sixtieth (0.0167) of the mean distance. The earth completes its revolution around the sun in 365¼ days, and its position is shown at intervals of four days. Intermediate positions and dates are easily supplied.

The sun is a great star moving swiftly through space with its attendant satellites the planets. Its axis, which is directed to a point about midway between Vega and Polaris, is inclined to the plane of the ecliptic, the equator making a small angle with that plane. Its diameter of 864,392 miles subtends at the earth a variable angle of a little over ½°, reaching its maximum value when the earth is at perihelion early in January, and its minimum when the earth is at aphelion early in July. The sun rotates on its axis in 25¼ days in the direction indicated by the arrows A, shown in the diagram of the major planets in 1917. Its apparent rotation in 27¼ days, or synodic period, is due to the revolution of the earth in its orbit in the same direction as the sun's rotation.

Eclipses

The apparent diameters of the sun and the moon do not differ very much, and as a consequence a solar eclipse may be either partial, annular, or total. In the present year there will be an unusually large number of eclipses as follows:

Partial eclipses of the sun January 22d, June 19th, July 18th; and an annular eclipse December 13th. Total eclipses of the moon January 7th, July 4th and December 27th.

The Terrestrial Planets

In plotting the orbits of the planets the distinction between their true forms and their projections on the plane of the ecliptic should be noted; but in a drawing whose dimensions are brought within the limits of this page this distinction is scarcely apparent. This is due to the small values of the angles which the planes of the orbits form with the ecliptic—the plane of the earth's orbit—which is represented by this page. The line of nodes, which is the line of intersection of the plane of a planet's orbit with that of the ecliptic, and which passes through the sun, is shown at NN′. The ascending node N is the point where the planet passes from the space below to that above the ecliptic; and N′ is the descending node. Perihelion is the point of nearest approach to the sun. The principal elements of the orbits are shown in Table 1, page 67, in which the mean distance of each planet from the sun is given in terms of the earth's mean distance; and the period in years is the planet's period of revolution around the sun.

Mercury. The inclination and eccentricity of this orbit are greater than those of any of the planets. In obedience to Kepler's law the orbit is an ellipse, one of whose foci is at the sun, with center at b. The planet makes a revolution in 87.97 days, and its position is shown for each day. The great rapidity of Mercury's motion at perihelion as compared with that at aphelion is apparent even in a plot of these small dimensions. Since Mercury makes more than four revolutions a year four dates are attached to each position.

Venus. The eccentricity of the orbit is so small that in the plot its centre is scarcely distinguishable from the sun. As a consequence the planet revolves at a nearly uniform velocity. The revolution is accomplished in 224.7 days. The dates from January to August are attached without the orbit, and for the remainder of the year within the orbit.

Mars. While the eccentricity of Mars' orbit is less than that of Mercury's, its linear eccentricity or actual distance from its center a to the sun, is greater.

The positions of Venus and Mars are shown at intervals of four days.

The Major Planets

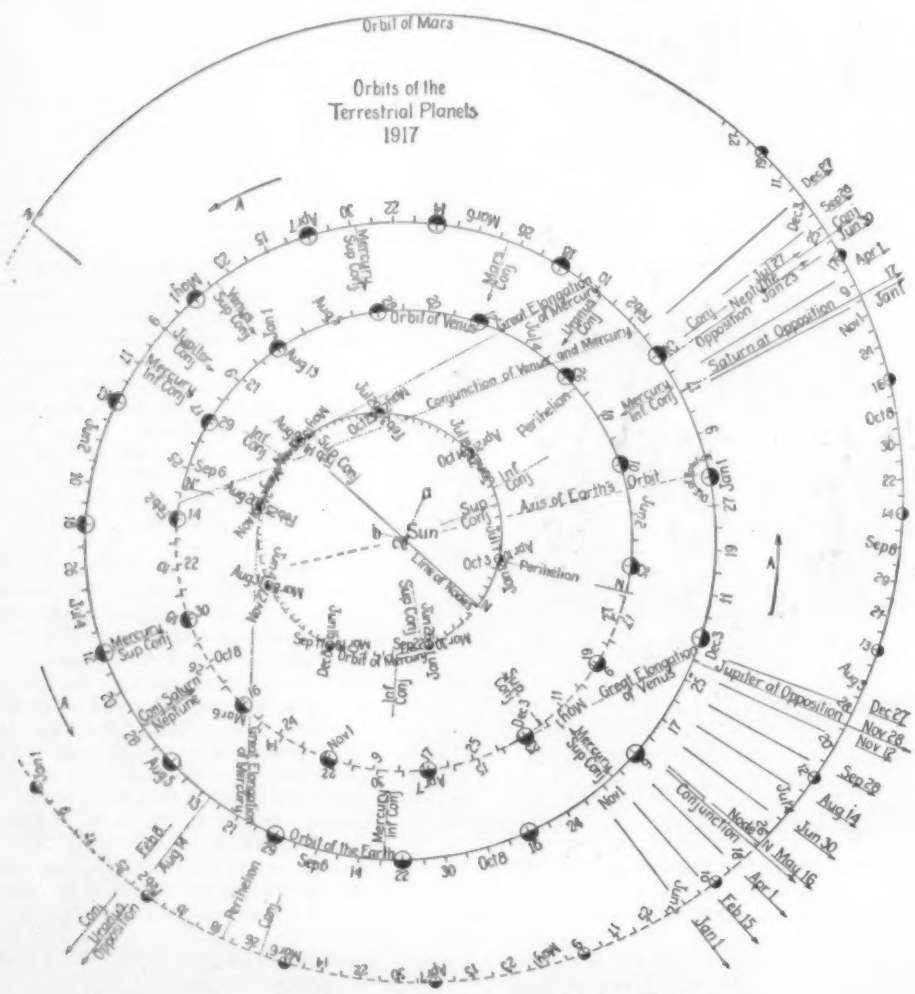
The scale is very much reduced, as will be apparent on comparing the orbit of Mars in the two plots. In the former the directions, as seen from the sun, of the planets Jupiter, Saturn, Uranus and Neptune are shown with the dates attached. Jupiter's position is shown at intervals of 45 days; Saturn's at intervals of 90 days; and those of Uranus and Neptune at the dates of conjunction and opposition. In the plot of the orbits of the major planets the planets' positions are shown for the first and last day of the year.

Conjunctions and Oppositions

The dates of conjunctions of planets with the sun and of oppositions are given in Table 2. It should be understood that the positions of the earth and of the other planets are given for Greenwich noon, and that the actual date of a conjunction or opposition is usually between the date given and that which follows. The number of hours is shown by the measurement on the orbit. For example, there are two conjunctions on July 27th; and one occurs nearly a half a day later than the other. A straight edge passed through the positions of the earth and planet at the date of a conjunction or opposition will pass through the sun.

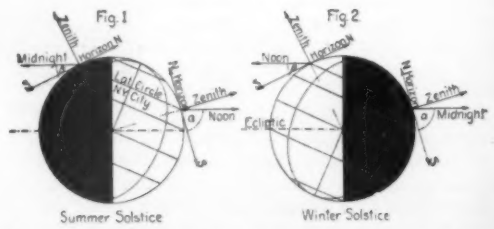
The dates for conjunctions between the planets are given in Table 3. If a straight edge is passed through the position of the earth and that of one of the planets it will serve as a finder for the other planet. If,

(Concluded on page 67)



The minor planets as morning and evening stars for 1917

The major planets in 1917



The course of New York City through the heavens in 1917

Model Prison to be Built in Illinois

Security from Escape and from Disease no Longer to Be Regarded as Incompatible

By K. H. Hamilton

WHEN the State of Illinois has finished her new three and one-half million dollar prison, features once thought essential to penal housing will be forgotten. Cell houses will have roofs of glass; the ventilating system will include an arrangement for washing the air used; every cell will be an outside one, and sunshine will reach them all at some hour during the day, as every one of the eight cell houses is round.

The many new ideas worked into the plans for this structure are attracting much attention from those interested in this class of buildings. By them a much safer, saner and more habitable prison will be the result. At the same time a system of control will be in use, which is pronounced by those in this country and abroad who have made a study of prison control, to be about perfection.

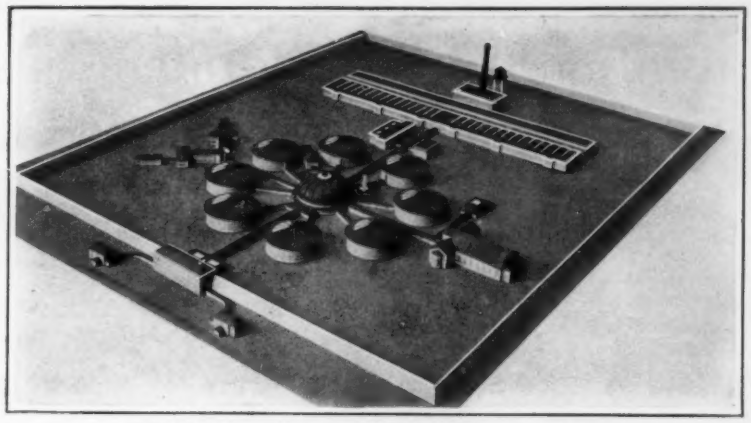
The cell houses, of which there will be eight, are built around a central dining hall. Corridor connections join all these to the central structure. Each cell house accommodates 250 prisoners, and has a diameter of 150 feet. Tunnels connect all cell houses to the administration building, which is at the entrance. In case of an outbreak all such connections can be immediately closed. Chapel and hospital are arranged for, these being on opposite sides of the cell house group. Dwellings of the warden and his assistants will be outside the prison wall near the administration quarters. The prison shops will be located not far from the hospital and chapel, while between shops and walls the pumping plant will be stationed.

The scheme for keeping an eye on the prisoners is the last word in such work. Every cell house has an observation tower in its center. Within this tower, which is darkened, the guard keeps watch through slits. Within his immediate vision are the rooms of the prisoners arranged in circular form. Prisoners will not know just when they are being watched. It is said that with this system of watch escape is impossible, nevertheless steel bars will further strengthen the system by being located at each window, inside and out.

Work on the structure has been under way for more than a month, the prisoners doing the work for the State, and thereby cutting the cost of labor. Two years would see this model prison completed, but the men who sit on the State's money bags may not make the entire appropriation. In such case five years will be required.

The site of the new home for criminals is a short way from the old. It comprises several thousand acres, purchased several years ago, but which until this year was farmed, its products feeding those confined within the prison walls.

With every cell in the prison having sunshine and the best of air, Illinois is doing her share toward safeguarding the health of her prisoners, and placing herself well above those States where a sentence of five years' imprisonment carries with it a virtual condemnation to an early tubercular death.

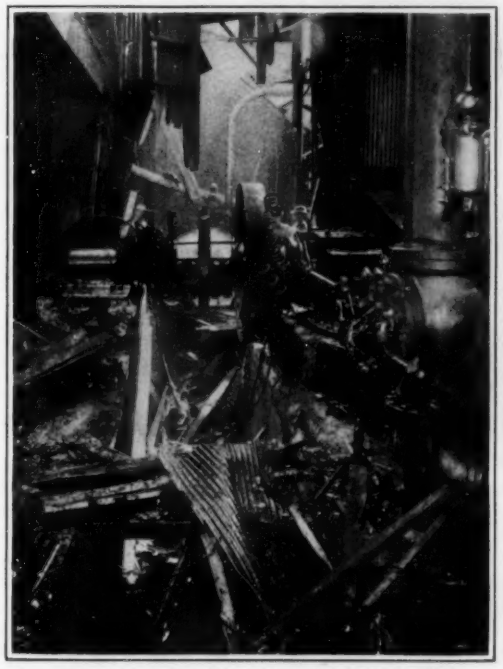


Illinois prison, at once humanitarian and escape-proof

When a Fly-Wheel Bursts

WE illustrate a large Kentucky rolling mill as it appeared after the smashing of the thirty-ton fly-wheel. We read now and again of the tremendous force in machinery when it runs wild—how the breaking of an eccentric causes the connecting-rod to tear a whole locomotive to pieces in a few seconds; but we seldom find a photograph taken after such an accident which shows anything more than a shapeless mass of ruins.

This wheel burst with a roar heard for a mile. One piece weighing a ton was hurled through a brick wall with such force that it left a hole big enough to admit a street car, and then traveled a thousand feet farther through the air. The whole plant was completely demolished, as our illustration indicates.



Wreckage caused by a bursting fly-wheel

An excellent conception of what happens when machinery is pushed beyond the proper limits of strength or speed is afforded by this accident, due as it was to the operation of the wheel at a velocity considerably greater than that for which it was designed.

The loss of production contingent upon such a casualty makes it an expensive folly to impose a higher peakload on a piece of machinery than the limit designated.

Soil Surveys in the United States

THE work of the U. S. Bureau of Soils has resulted in the investigation and mapping, either in detail or reconnaissance surveys, of 571,463,680 acres, or 892,912 square miles, of soils. During the past year 24,749,440 acres, or 38,671 square miles, in 32 States, were mapped in detail. In every State of the Union several areas have now been surveyed, and one survey has been completed extending across the island of Porto Rico. A special undertaking of the past year was field work for the study of the trucking soils in certain typical areas in New Jersey. Similar work has been begun in the vicinity of Norfolk, Va. In 19 States the work of the bureau is carried on in coöperation with the state authorities. It is expected this work will augment farming acreage.

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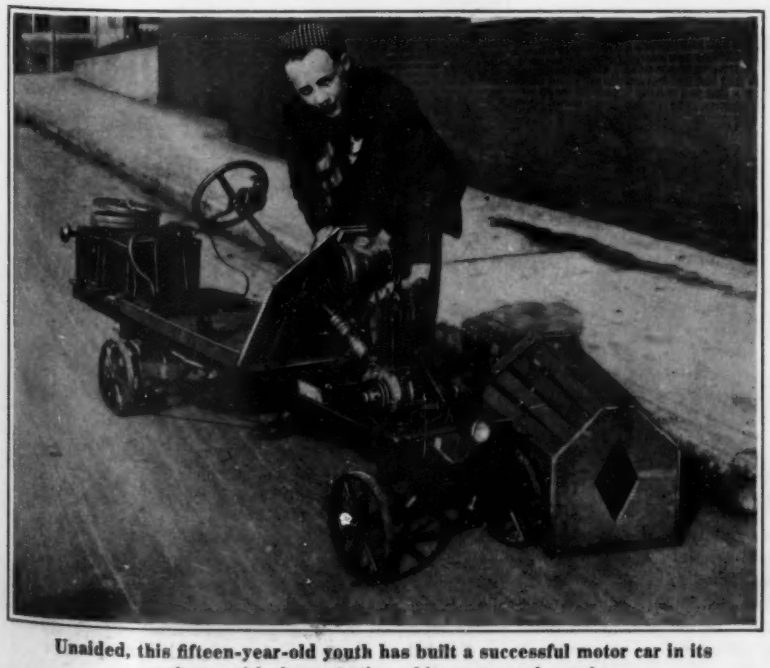
A Juvenile Builder of Automobiles

HAVING built a successful and withal serviceable car at the age of fifteen years, Cleage Field of Knoxville, Tenn., can safely lay claim to being one of the youngest automobile builders in the world.

Young Field has constructed a perfect automobile unassisted. With the exception of the engine, which, as is customary with many car manufacturers, he has purchased elsewhere, the car is entirely a product of his handiwork. The engine was formerly doing service on a motorcycle.

When asked about his car, which he classes as a roadster, the young builder gave the following facts: "It took me about a month to build it. I had to work out all my plans. I use spark instead of throttle control, and have attained a speed of 20 miles per hour. With my belt transmission I can get practically six speeds. I use four dry cells and have an electric headlight. My gasoline tank holds one-quarter of a gallon and I can get 35 miles out of a gallon of gas. My gear is 2½ to 1. I have a foot brake and horn. The steering gear is worked by ropes. My clutch is absolutely my own invention as I get my power from the engine to the wheels by a belt which is slack when I push in what I call the clutch. This is a small wheel that I press against the belt, causing it to tighten up and get the pull into the wheels from the engine."

A person visiting Knoxville any clear day is almost certain to see young Field driving through the streets. His speed is only limited by the traffic regulations.



Unaided, this fifteen-year-old youth has built a successful motor car in its entirety, with the exception of its motorcycle engine

Visitors in Knoxville, Tenn., are almost certain to see this diminutive automobile traveling through the streets of the town

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

"Safety First" In Horse Fountains

THE latest safety device for the horse, to prevent the spread of disease, is a specially constructed fountain which prevents the animals from drinking out of the same body of water at one time. The fountain contains several small cups or basins only large enough for one animal and these cups are filled by water coming through the bottom of the cup with considerable force and overflowing the rim. It is a continuous flow and the waste water is carried into the large fountain from which it immediately empties itself into the drain pipes and thence to the sewer.

A test was made during the last winter with one of these fountains and it was found that it was serviceable for all weather; with a temperature of 12 degrees below zero there was no ice in the individual cups or fountain.

It would seem that this plan might solve the problem which has bothered the humane societies and the owners of horses for the last few years, since the disease of glanders among horses has become so prevalent.

A Novel British Tram Rail Wear-Gage

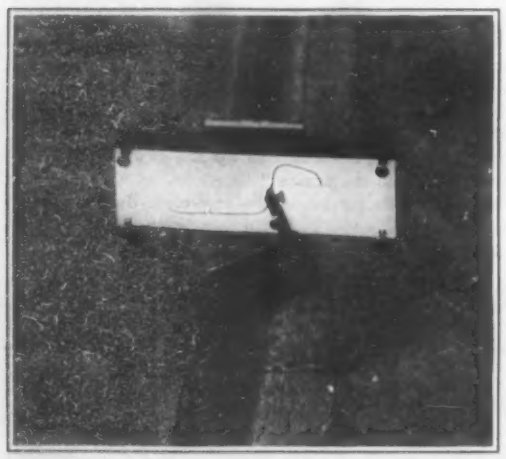
By Frank C. Perkins

THE accompanying illustration shows a unique trolley rail wear-gage developed at Manchester, England. This gage was designed to obtain an accurate profile of worn rails without disturbing the paving, and is the outcome of many modifications suggested by practical use on the road. It operates on the principle of the pantograph, gives an absolutely accurate profile of the rail direct on the strip of paper inserted in the instrument, and is simple and expeditious to use. The bearing surface for the sliding links is dead true, the links moving freely and easily, but without slackness. The scriber is of steel, easily removed for sharpening or renewal, and marks are indicated to which the pencil and scriber are to be set.

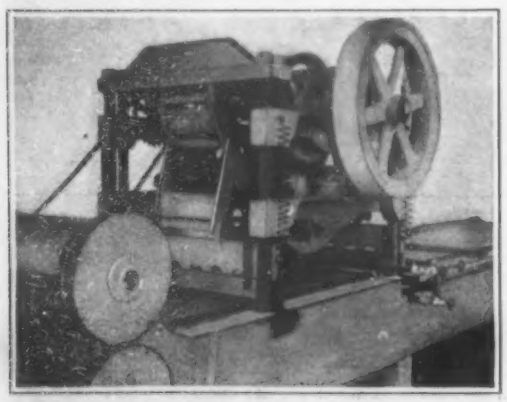
There is a small spirit level mounted on top of the instrument, and a folding leg fitted behind to enable setting, both horisontal and vertical, to be readily performed. The instrument has adjustable contacts which make it capable of dealing with all the standard sections of steam or street rails, or it may be marked to suit any particular section. It is simple and expeditious in use, is not attached to the rail in any way, and so can immediately be withdrawn on the approach of a train.

It is pointed out that by its use an absolutely accurate profile of the rail surface, referable to the original section, is obtained direct on the slip of paper inserted in the instrument. The small level shown in illustration can be so fitted to the instrument, if desired, as to refer the profile obtained to the horizontal.

Another unique instrument, quite similar to the one illustrated, is the wheel wear-gage which records by means of the pantograph the actual profile of the wheel direct on a strip of paper inserted in the instrument, while the scale on the side gives the thickness of the tires where such are fixed. It is applicable to any diameter, width or shape of wheel, and does not necessitate the removal of the wheel from vehicle, as the section can be taken in any position.



Testing the wear on a rail by means of the pantograph principle



Machine for making tin-plate rolls

Individual drinking cups for the horse

Tin Plate in Rolls Instead of Sheets for Roofing

TIN plate in the shape of continuous rolls, like tar paper, instead of in the shape of flat sheets as at present, is now possible. A power-driven soldering press has recently been designed for joining and soldering the sheets into a continuous strip for roofing purposes. This machine, shown in the illustration, consists of two presses or dies that operate simultaneously, one heated by gas or electricity or both, the other cooled by water circulation, both being mounted in one frame and operated by rollers, cams and toggle joints.

The sheets, with a lock turned on the edge, are hooked together and fed into the machine, one seam being hot pressed while the seam before it is cold pressed. The movement of the sheet through the machine is controlled by a stop that holds the metal stationary during the pressing operations. After being seamed the sheet passes to a reel on which it is wound up into a roll. The motion of the reel is imparted from another underneath on which the upper one rests, the lower reel being chain driven from the main shaft.

One man operates the machine, hooking the sections of tin plate together and operating the solder and flux on the seam. The capacity is four seams per minute or twenty boxes of tin plate per day. It is claimed that by use of this machine, a better and more durable seam can be made than by hand, and one that will be solid and uniform on both sides, the solder penetrating and welding all parts of the seam. The economy and convenience to the roofer, from the tin-plate roll thus produced need not be pointed out. The process of roofing with tin becomes identical with that of roofing with tar-paper rolls.

Wanted—Fourth Assistant Examiners for the Patent Office

THE Patent Office is having difficulty in securing a sufficient number of qualified men to take the position of fourth assistant examiner. Since July 1st, 1916, twenty-nine fourth assistant examiners have been appointed, and this has exhausted the list of eligibles on the Civil Service eligible list, although several extra examinations have been held. The Civil Service Commission has called an examination for January 17th, 18th and 19th, 1917. The subjects of examination are technics, physics, chemistry, reading a drawing of some selected machine, mathematics and French or German.

The eligible list, from the nature of the examination, is filled largely from college graduates and the Civil Service law works a peculiar hardship in this case where the Office is finding it so difficult to keep its quota full, since the law requires a candidate to stand the examination at his legal residence, which would necessarily require most college students to go to their homes to stand the examination. If the law permitted these candidates to stand the examination at their college town, the difficulty of keeping the eligible list full would probably be obviated. Fourth assistant examiners in the Patent Office receive $1,500 a year salary and the chances for promotion are far better than in most government bureaus.

Those wishing to enter the examination should communicate with the Civil Service Commission.

Patents in the Court of Claims

HON. HUSTON THOMPSON, Assistant Attorney-General in charge of the defense of suits against the United States in the Court of Claims in his report of October 10th, 1916, to the Attorney General suggests that it is believed that no other nation has gone so far in submitting itself to suit as has our Federal Government, which by a long series of acts of Congress, has submitted itself to suit so that any citizen of the United States or any citizens of foreign countries whose government allows Americans a reciprocal privilege, may sue the Government of the United States upon any debt, claim, or obligation of a contractual nature, and also in respect of patent rights, even where the basis of claim

(*Concluded on page 67*)

Smoke-Piercing Searchlight for the Use of Firemen

ONE of the latest additions to the already splendid equipment of the Cincinnati Fire Department is a type of acetylene-gas searchlight which, it is claimed, is sufficiently powerful to pierce the densest smoke clouds. The apparatus, it will be noted in the accompanying illustration, is strapped on the fireman's back when he enters a dark or smoke-filled building. The projector is rated at 3,000 candlepower, and one charge of calcium carbide is sufficient for more than four hours' constant use. The gas generator may be recharged in a minute and a half.

Carried on the fireman's back, this lamp pierces the densest smoke

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Patents in the Court of Claims

(*Concluded from page 66*)

is not contractual but tortious. Numerous patent suits are therefore decided by the Court of Claims. While the report of the Assistant Attorney-General does not separate the amounts claimed and recovered by payments into the different forms of suits so that the amount involved in patent suits can be readily determined, his report does show that out of 2,098 cases disposed of during the year the amount claimed in such cases was $12,755,809.98 and amount recovered was $1,206,485.77.

Morning and Evening Stars for 1917

(*Concluded from page 64*)

however, the drawing were made on a larger scale it would not actually pass through it because the conjunctions of the planets are in right ascension as distinguished from conjunction in longitude.

Morning and Evening Stars

In order to obtain a clear understanding of the relative positions of the planets for any day in the year, the plot of the orbits of the terrestrial planets should be moved into a position where the earth is between the reader and the sun for the assigned date, and when the dates attached to the terrestrial planets may be read without turning the head. A straight edge passed through the earth and sun will divide the planets into two groups, viz.: those on the right hand which rise before the sun and are morning stars, and those on the left hand which set after the sun and are evening stars. The direction of the earth's rotation which determines the rising and setting of the sun and planets is shown by arrow at position, January 1st.

Mercury has his great elongation from the sun on January 2d, February 11th, April 24th, June 11th, August 22d, October 4th, and December 16; Venus on November 29th. On account of the planet's great distance from the sun on February 11th, Mercury's position will be very favorable for observation as morning star; and on August 22d as evening star. A planet may also be seen advantageously for some time prior and subsequent to the given date. Venus will be evening star after April 25th—the date of superior conjunction. The distance from the sun will gradually increase until the planet reaches greatest elongation on November 29th.

TABLE 1

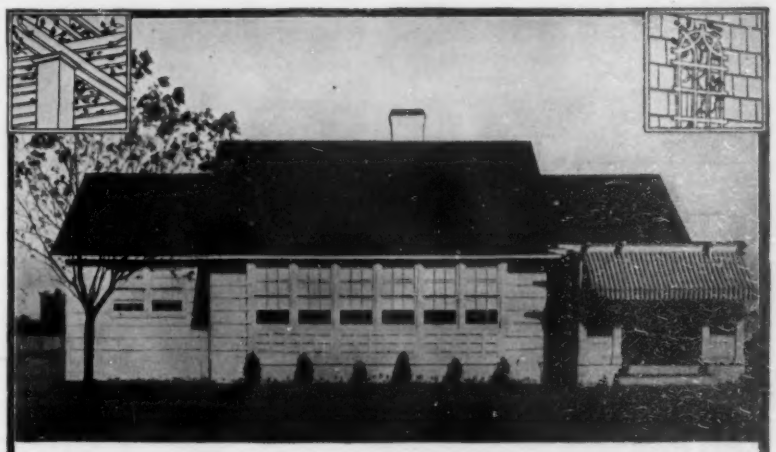
Planet	Diameter Miles	Mean Distance	Period Years	Velocity per Sec.	Excentricity of Orbit	Inclination to Ecliptic
Mercury	3008.54	0.387	0.241	23 to 35	0.206	7.00
Venus	7701.48	0.723	0.615	21.9	0.007	3.39
Mars	4548.84	1.524	1.881	15.0	0.093	1.85
Jupiter Equatorial Polar	90256.02 84779.42	5.203	11.862	8.1	0.048	1.31
Saturn Equatorial Polar	76456.40 69781.78	9.539	29.458	6.0	0.056	2.49
Uranus	30193.44	19.191	84.015	4.2	0.047	0.77
Neptune	34823.34	30.071	164.788	3.4	0.008	1.78

TABLE 2—Greenwich Time

Planet	Conjunction	Opposition
Saturn	.....	Jan. 17
Mercury (Inf)	Jan. 18	.....
Neptune	.....	Jan. 23
Uranus	Feb. 8	.....
Mars	Feb. 28	.....
Mercury (Sup)	Mar. 29	.....
Venus (Sup)	April 25	.....
Jupiter	May 8	.....
Mercury (Inf)	May 16	.....
Mercury (Sup)	July 12	.....
Saturn	July 27	.....
Neptune	July 27	.....
Uranus	.....	Aug. 14
Mercury (Inf)	Sept. 18	.....
Mercury (Sup)	Nov. 3	.....
Jupiter	.....	Nov.28

TABLE 3—Conjunctions of the Planets

Jan. 13	Mercury and Mars
Jan. 30	Mercury and Venus
Feb. 2	Mars and Uranus
Feb. 24	Venus and Uranus
Mar. 2	Mercury and Uranus
Mar. 18	Mercury and Venus
Mar. 23	Mercury and Mars
Mar. 30	Venus and Mars
April 16	Mercury and Jupiter
May 5	Venus and Jupiter
May 13	Mercury and Venus
May 24	Mercury and Jupiter
June 5	Mercury and Mars
June 8	Mars and Jupiter
June 8	Mercury and Jupiter
June 11	Mercury and Mars
July 4	Venus and Saturn
July 6	Venus and Neptune
July 18	Mercury and Saturn
July 18	Mercury and Neptune
July 30	Saturn and Neptune
Sept. 21	Mars and Neptune
Oct. 1	Mars and Saturn
Dec. 30	Venus and Uranus



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RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

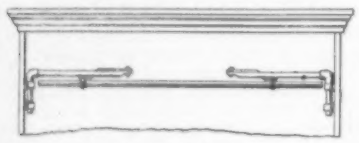
Pertaining to Apparel

UMBRELLA.—R. M. SOUTH, 114 Hamilton St., Palmyra, Mo. In this case the invention has reference to umbrellas and parasols, the object being the provision of an improved article of this type which may be readily manipulated by one hand, thereby leaving the remaining hand free for any other purpose.

FRAME FOR WOMEN'S HATS.—J. HUTTER, care of Frederich F. Eiseman, 41 Park Row, New York, N. Y. In this case use is made of a brim formed of an outer and an inner section, of which the inner section is made of an open mesh relatively stiff material, and the outer section is made of a flexible or pliable material capable of being bent to assume and retain the desired shape.

AUTOMOBILE CAP.—F. RAUDNITZ, 38 E. 21st St., New York, N. Y. This invention relates to head coverings known as caps which are provided with a visor for shading the eyes of a wearer. A wearer of this cap is enabled to turn the visor down into conventional position, or to turn it up out of the way, without affecting the normal relationship of the cap with respect to the head of the wearer.

GARMENT HANGER.—M. J. CASEY, New Richmond, Wis. This invention relates to garment hangers, and is a modification of the structure shown and described in Letters Patent of the U. S. No. 1,156,755, issued to Mr. Casey, and the object thereof is to provide garment suspension means within a cabinet which means,



GARMENT HANGER

together with the garments, may be readily moved outwardly of the cabinet for garment display or removal, as in a store. The engraving gives a fragmentary view of the front of a cabinet provided with the garment suspension means in garment storage position.

SPRING DRESS FASTENER.—W. MILLER, 43d St., Oswald's road, Small Heath, Birmingham, England. This spring or snap dress fastener is not liable to injury in such laundry operations as mangling and ironing. The invention comprises the use as one element of the fastening of a flat spring metal ring which can be detachably engaged by a projection from the complementary sort of the fastening. It comprises the employment of a pair of similar flat spring metal rings which are detachably engaged by an intermediate connecting piece.

HAT FRAME.—O. G. SAMISH, 35 W. 37th St., New York, N. Y. In this instance the object is the provision of a new and improved frame for women's hats, arranged to prevent the frame from stretching and producing distortion of the shape of the frame, at the same time rendering the frame exceedingly strong and durable.

BATHING SHOE.—J. KIMMEL, 223 E. 75th St., New York, N. Y. Among the objects of the invention is to improve this class of shoes with respect to comfort and durability when subjected to the sea water. Another object is to improve the construction of bathing shoes adapting them to retain their shape and present a neat appearance for the longest possible time.

UNION SUIT.—W. K. JONES, 1501 N. Holyoke Ave., Wichita, Kan. This invention relates to an improved construction and arrangement of the rear portion of a union or combination suit, whereby certain advantages are obtained in respect to attachment, adjustment, and manipulation of the jacket flap or skirt and the drop flap.

SUPPORT FOR PRESSING IRONS.—J. RATNER, New Brunswick, N. J. Among the objects of this invention is to provide a means whereby the tailor or other operator is relieved from the expenditure of strength and time required in carrying the pressing iron to a distant point where it is ordinarily supported out of the way of the operator while preparing the garment for another operation.

Electrical Devices

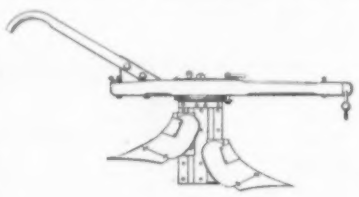
DEVICE FOR RECORDING TELEPHONE CONVERSATIONS. G. JOHNSTON, 505 W. Franklin St., Richmond, Va. The object of this invention is to provide a device which may be used in connection with an ordinary telephone, such as a desk telephone, and an ordinary phonograph of the cylinder type, for recording the entire conversation between two parties who are using the telephone.

Of Interest to Farmers

SAP SPOUT.—G. H. SOULE, Fairfield, Vt. This invention provides a spout with means for completely sealing the sap-gathering bore with which the tree is provided, to compel the sap to pass through the channel furnished in said spout; provides means for automatically fastening the spout in the bore to prevent the withdrawal therefrom; and provides a detachable hanger hook and a protective cover therefor.

FLOUR BIN.—H. F. COPPES, care of Coppes Bros. and Zook, Nappanee, Ind. This improvement provides a structure which may be raised and lowered or moved from one position to the other with a minimum effort. It provides a bin which may be moved pivotally to a lower position, and when in such a position will expose a filling opening at a convenient height.

PLOW.—J. DOWLING, R. R. No. 1, Powell, Wyo. This invention relates to a plow having a pair of plowshares disposed back to back on the plow standard and a beam adapted to be turned through an angle to present either of the said



PLOW

plowshares at the front. More particularly it relates to a plow in which the plowshares are separately mounted on the plow standard for vertical sliding movement and means for simultaneously sliding the plowshares in opposite directions to raise either share and depress the other to working position on the standard.

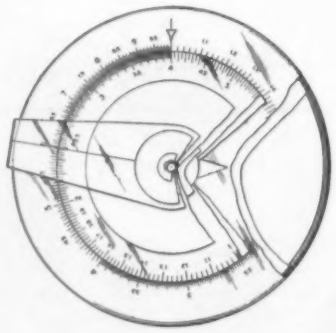
Of General Interest

BOOK-HOLDER.—D. P. O'BRIEN, 291 West St., West Hoboken, N. J. An object in this instance is to provide a book-holder with a book mark that acts in several capacities including a book-mark, an opening or turning member and a brace for holding the book and book-holder in an open position whereby the book-holder acts as an easel.

FRAME.—J. A. NONES, care of Selmore, Inc., 35 E. 12th St., New York, N. Y. The invention provides a frame for use in the construction of signs, show cases and other structures and devices which is simple, exceedingly strong and durable in construction, cheap to manufacture and capable of holding a glass pane or other article to be framed.

DISPLAY CASE.—J. A. NONES, care of Selmore, Inc., 35 E. 12th St., New York, N. Y. This invention relates to the display of goods in their original containers, wherein the containers have hinged lid or cover, as cigar boxes, and provides means, for protecting the goods from dirt, dust, etc., by means of a supplemental, transparent, cover with the lid of the container in open position, whereby the goods are exposed to view, but in a thoroughly sanitary manner.

CALCULATOR.—L. E. PICOLET, Box 4, Bala, Pa. This invention provides a calculator in which the divisions of the scales are protected from injury, although clearly visible. It provides a disk calculator, easy of manipulation and



CALCULATOR

certain in action, with which various arithmetic operations, such as addition, multiplication and evolution may be performed according to the nature of the graduations inscribed thereon.

BOOKKEEPER'S POSTING GUIDE.—P. P. GORDON, Box 25, Sorrento, La. The improvement facilitates the location of items to be posted or transferred from one book to another, and to this end the inventor includes a pair of base plates hingedly connected and adapted to engage in the groove formed by the pages of a book where the same is opened, said plates having indicator supporting arms extending therefrom and transversely of said pages.

EXPOSURE METER.—W. W. VENABLE, 2423 Washington St., Charleston W. Va. This improvement refers to exposure meters for use in photography. It provides a device by means of which the time of exposure may be quickly ascertained under varying conditions of light, kind of plate or film used, time of the year, number of the stop, etc.

BOTTLE CASE.—F. DISTLER, 19 Beaudette St., Pontiac, Mich. The invention relates to bottle cases in which provision is made for holding bottles upright and for holding other bottles inverted and disposed between the upright bottles. Provision is made in this invention for the accommodation of the bottles and the means to securely hold them in position.

PICTURE OR SIGN FRAME.—E. REACH, 31 Oakland St., Jersey City, N. J. The inventor provides a frame for pictures, signs, cards and like articles, which is cheap to manufacture, highly ornamental in appearance, sets off the picture, protects the same against dust, and protects the edges of the pane of glass covering the picture.

BACKING APPARATUS.—E. KEEFE, care of *Colliers' Weekly*, 416 W. 13th St., New York, N. Y. This improvement provides an apparatus arranged to reduce the number of operations to a minimum by the use of a very simple apparatus and without the danger of splashing the molten metal and dispensing entirely with the use of ladles and overhead means for carrying the tray or pan containing the shell from one apparatus to another.

CIGARETTE CASE AND HUMIDOR THEREFOR.—J. J. KING, care of Frankfort Hotel, Frankfort, Ky. This invention relates more particularly to improving the general structure of the casing and the provision of the casing with means for detachably holding the humidor. It further relates to the construction of the humidor whereby it is rendered easily detachable from the cigarette case.

WATER TIGHT CEMENT AND PROCESS OF PRODUCING THE SAME.—A. M. H. HANSEN and M. C. J. NEVE, 3 Ober-Bergfeld and 1 Treskowstrasse, Hamburg, Germany. This invention relates to a process of producing a water-tight cement. The primary object is to produce a hydraulic cement which is really water-tight, and which can be effectively produced in a simple manner without in any way prejuding the excellence of the other qualities of the cement.

DECORATED TRANSPARENT ARTICLE AND PROCESS OF MAKING SAME.—A. FRIEDRICH, 53 W. 16th St., New York, N. Y. An object here is to provide a transparent article which may be decorated with any desired gold design and in which the gold of the design is protected from air or liquids that may be carried by the article and thereby produce a more sanitary article.

PROJECTILE.—G. DAMER, U. S. N., 1532 Snyder Ave., Philadelphia, Pa. This projectile is more especially designed for destroying wire entanglements, aerial craft, masts, fighting tops, wireless aerials and like structures, which is arranged to permit of firing the projectile from a gun the same as an ordinary projectile and without danger of injuring the bore of the gun.

CONCENTRATOR.—E. R. SHAHAN, 1729 Hague Ave., St. Paul, Minn. The main object here is to provide an apparatus wherein in the flow of ore pulp in one direction is met by a flow of water, or water and air, in the opposite direction, said water or water and air being under sufficient pressure to remove the sludge from the pulp but not enough to prevent the setting of the concentrates.

FILTER.—U. HOKE, Cornwall, Pa. The filter is especially adapted for portable use, as for instance, by travelers, soldiers, and the like, wherein the filter may be connected with the ordinary canteen, in such manner that the canteen may be filled by water passed through the filter, and wherein a cup is detachably connected with the inlet of the filter to permit the canteen to be filled.

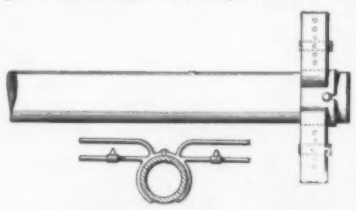
PROCESS OF TREATING SIGNITE.—C. MELHARDT, Starnberg-Munich, Germany. The present invention relates to a process for utilizing the qualities of certain materials for obtaining a continuous deprivation and driving off oxygen or, as the case may be, nitrogen combinations, and to improve the calorific effect. The heat required for separating the chemical combinations can be produced by electrical current.

PUMP PLUNGER.—W. J. LILLY, 810 W. Galena St., Butte, Mont. This plunger consists mainly of acid-proof material so arranged as to be effective in all respects required by a pump plunger and yet possessing great strength coupled with simplicity—the external portion of the pump plunger being not only very smooth but impervious to the corrosive action of acids and the like with which the water to be pumped is impregnated.

HOLDER FOR WRIST WATCHES.—J. A. POLTOCK, Woodridge, N. J. The improvement provides a holder for wrist watches arranged to readily accommodate watches of different sizes, to present no projections whatever on the face of the watch, thus preventing dress parts, laces and other finery from being caught and torn while the wrist watch is in use.

BUFFER FOR COUPLINGS.—R. H. ALDRICH, Allentown, Pa. This invention relates to flexible couplings, and has reference more particularly to the buffers of the coupling. The purpose of the invention is to provide a simple, inexpensive and durable buffer of compressible material provided with yielding reinforcing parts.

GUN SIGHT.—D. A. LE BARON, Box 41, Mesa, Ariz. The object in this case is to provide a gun sight for use of sportsmen and game hunters, to enable them to instantaneously obtain the required lateral lead when firing a cross-shot at a



GUN SIGHT

bird or other moving object, thus obtaining the desired accuracy of aim. As shown in the accompanying engravings the body has a notch in its upper side and front edge to receive and engage the front sight.

ADVERTISING MEDIUM.—W. L. BURFORD and A. E. ALBIN, 83 South 9th St., Brooklyn, N. Y. This medium is preferably associated with a bill board located in close proximity to a sidewalk, station platform or other place frequented by the public, and arranged to attract the attention of passersby by a pleasing odor in the atmosphere and corresponding to that of an article which forms the matter of the advertisement on the bill board.

EDUCATIONAL APPLIANCE.—C. ENGEL, 217 E. 25th St., New York, N. Y. This inventor provides a simple and easily manipulated apparatus for illustrating the relationship of the polar axis of the earth to the North Polar Star. He also indicates visually the inclination of the Earth's axis, according to the latitutde of any particular place.

COLLAPSIBLE BOX.—H. E. WENDELL, Gulfport, Fla. This improvement provides a structure with double-wall protection on all surfaces and reinforced, when folded, by rigid triangular double thick corners showing no raw edges, the corners normally assuming folded positions during erection, rigidly binding the several units in their proper places, and guarding against collapse of the structure under external pressure and preventing outward bulging from internal pressure, as well as obstructing the entrance of insects and foreign matter and preventing the leakage of loose contents.

Hardware and Tools

AUTOMATIC HAND LEVEL.—J. I. D. BRISTOL, Villa Perry, Perry Heights, Chappaqua, N. Y. This improvement provides an instrument that is adapted especially for hand-operation, the same being easily manipulated and possessed of sufficient accuracy for ordinary purposes, such as laying out lawns, gardens, landscapes, tennis courts, or in approximating the altitude of distant objects or locations.

MICROMETER MEASURING INSTRUMENT.—R. W. FIELDWICK, Cromer House, 170 Upper Richmond road, Putney, London, S. W., England. The inventor provides improved means whereby an ordinary screw-operated micrometer caliper may be used as a "go" and "not go" limit gage having any desired tolerance, such tolerance being not greater than that which is permitted by an almost complete revolution of the micrometer adjusting piece.

ROPE CLAMP.—E. HELLER, 428 30th St., West N. Y. P. O., Woodcliff-on-Hudson, N. Y. This invention relates to a rope clamp particularly adaptable for clotheslines. The object thereof is the provision of a simple, inexpensive, and efficient clamp whereby the line can be easily slackened or tightened without any danger of the rope becoming jammed due to atmospheric conditions.

TOOL HANDLE.—B. A. GREENGOOD, 83 E. 111th St., New York, N. Y. This invention relates to handles for tools of various kinds and has particular reference to handles to be attached to soldering irons or the like, whereby the operator's hand will be protected from the heat. The object is to provide a handle of a more durable and substantial nature, without materially increasing its cost, than other handles heretofore proposed fo similar purposes.

RAZOR STROPPER.—B. TROSKY, 57 W. Houston St., New York, N. Y. This invention has reference to a razor stropper of that type comprising a pair of rotatable stropping elements between which is held the blade to be stropped, whereby the edge of the blade is sharpened by the elements acting thereon.

STRAIGHT EDGE.—D. T. MORGAN, 1534 South Meridan St., Indianapolis, Ind. The invention has for its purpose the provision of a straight edge particularly well adapted for use by paper hangers, and having means by which the edge may be straightened should the wood of which the body of the straight edge is manufactured swell or warp.

RAKE.—B. TERWILLIGER, 639 N. 2d St., Grants Pass, Ore. This invention provides mechanism for use in connection with rakes of ordinary construction, but more especially that type known as grass rakes, wherein a plate is provided, having openings for receiving the teeth and movable on the teeth to remove accumulation of leaves and the like from the teeth of the rake, and wherein other mechanism is provided adapted to be mounted on the handle for moving the plate on the teeth.

KEYLESS LOCK. B. A. HURWITZ. Address, Heyman E. Golden, Atty., 399 Broadway, New York, N. Y. This invention provides a lock including dials upon both the inner and outer faces of a door, so arranged and constructed that the combination may be readily changed from the inside of the door only, and whereby, such change may be readily and conveniently effected.

DRILL.—F. R. WEATHERSBY, 312 Scanlan Bldg., Houston, Tex. The invention provides a drill which may be mounted upon drill pipes of different diameters, and which carries a cutting blade so formed as to guide the drill accurately even when the drill encounters surfaces of varying degrees of hardness, and especially under conditions where drills of ordinary form would most likely be diverted from their proper paths of travel in descending into the earth.

Heating and Lighting

FUEL BRIQUETING PLANT AND THE LIKE.—T. RIGBY, Station Hotel, Dumfries, Scotland. This invention has reference to the drying, conveying and superheating of fuel in briqueting plants or similar installations and particularly to those installations in which fuel containing a substantial percentage of water is dried prior to briqueting.

LAMP.—F. L. GODINEZ, 235 Fifth Ave., New York, N. Y. This invention provides a lamp with a system for furnishing a restricted area with diffused light for combined direct and indirect illumination, and a second system for furnishing an unrestricted area with clear light for indirect illumination; provides means for at will discontinuing the service of either or both said systems; provides means for controlling the intensity of the source of diffused light; and pro-

(*Concluded on page 70*)

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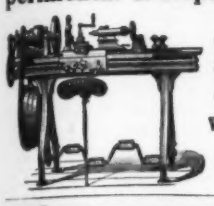

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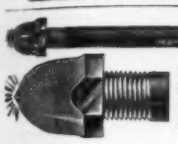

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Managing Director

Machine Guns by the Thousands

(Continued from page 63)

The parts of the gun as they are completed are sent to the company's inspection room where they are gaged and carefully inspected, piece by piece. The gaging is unusually severe, for the pieces have to come within a fractional part of a thousandth of an inch from a fixed standard; in fact, the tolerance allowed in the chambering operations is but one-quarter of one-thousandth of an inch. After passing the company's own inspection the parts are sent to the stock room, where they are placed in individual bins from which they are later assembled into pans. Each pan is given a number which is to be that of the finished gun, and enough parts are placed in each pan to make up one gun.

The pans are handed out upon application to what are termed "soft fitters," who assemble the parts into the complete gun and operate its mechanism by means of belts containing dummy cartridges. By the manual operation of the bell-crank of the gun it is possible to simulate the conditions of actual firing—the feed wheel draws the cartridges into the mechanism, one by one, the extractor plucks them out of the belt, the carrier raises them into the breech, and the ejector ejects the supposedly fired cartridges. Following the assembling and successful operation of the gun, the "soft fitter" takes it down and places the parts in the pan which is then returned to the stock room.

Certain parts of the gun are now hardened and blued while others are merely blued; and after being returned to the stock room they are again placed in the pan with the companion parts for that particular gun. The pan is again given out, but this time it is the "hard assemblers" who reassemble the parts and thoroughly test out the complete weapon with dummy cartridges to make sure that the feed action and ejection are operating satisfactorily.

Inspections That Preclude Failure on the Battlefield

Once more the company's inspectors examine the gun in its finished form, and if no fault is to be found it is sent to the firing room where it is fired for the first time under the ever-watchful eyes of the Russian inspectors. The firing room consists of several booths, each provided with a metal-lined loop-hole in which the machine gun to be fired is placed. The loop-hole gives access to a heavily padded room with a sand bank at its farther end, and it is into this sand bank that the streams of lead are discharged. Each gun is fired 200 rounds in all; 170 rounds are fired with one barrel and 10 rounds for each of the three extra barrels furnished with every gun. The first string of cartridges is intended as a mechanism test and a test of the chambering of the first barrel, while the remaining strings of ten cartridges each are intended for the chambering of the extra barrels.

The guns are then sent into an adjoining room where the barrels are cleaned out to remove metal fouling and powder residue, preparatory to final inspection. It is well to add here that the barrel of the gun can be removed and another substituted in less than a minute. Resting a barrel when heated prolongs the accurate life of the barrel.

Passing now to the Russian inspectors' department, the gun is entirely taken down and all pins, bolts, linkages, and other parts are carefully examined. The Russian government maintains a force of 25 to 30 men at the plant for the inspection of the parts, the complete guns, the accessories, the packing, and other phases of the work. Many intricate and delicate tools and gages are used by them in their inspections, for the Russians know only too well what a defective gun has meant in the past on the plains of Poland.

After the official inspection the usual procedure is to reassemble the parts into the same gun; but occasionally, to test the interchangeability of the parts, the components of five different guns are mixed indiscriminately and five new guns

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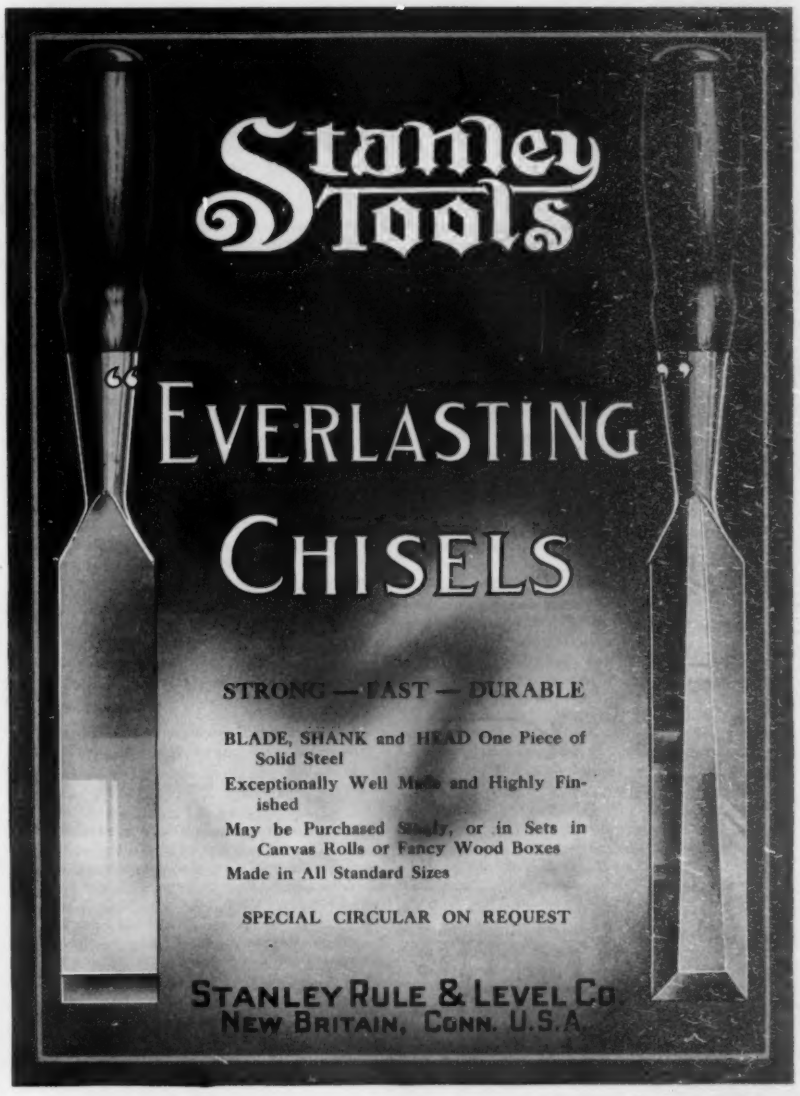
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RECENTLY PATENTED INVENTIONS

(Concluded from page 68)

vides means for concealing from lateral points of view the illuminating elements in the lamp.

Household Utilities

WINDOW JACK.—O. W. SANDHOLM, 43 North Chase Ave., Rockaway Beach, N. Y. In this case the invention refers to seats and particularly to a window sill seat or jack, and has for an object the provision of an improved arrangement whereby the same may be applied and removed quickly and when applied be held against accidental removal.

SIFTER.—G. B. WHEELER, 2069 Third Ave., New York, N. Y. The invention relates particularly to sifters for sifting salt, soap, powder and the like where limited quantities are desired from time to time, and provides an arrangement whereby any desired quantity may be secured and when the device is not in operation the discharge openings will be closed.

HAM SHAPER.—H. ADELMANN, 530 Westchester Ave., Bronx, N. Y. This invention relates to improvements in cooking meats, with particular reference to hams and corned beef and the like, in which the meats are preferably delivered in a compressed form, suitable for slicing, the bones and inedible parts being removed preliminary to the cooking.

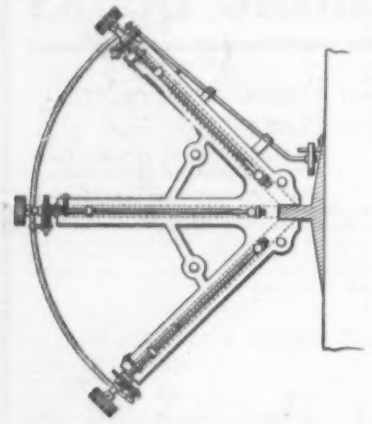
BED SPRING.—F. W. HILL, Lyndonville, N. Y. This invention provides a spring mattress frame having a joint so that one part may be positioned at an angle to another part and so supported in position as to provide a head rest in the case of a bed mattress or couch, or a back rest in the case of a chair or the like, but having facilities whereby the movable section may be restored to normal position in the same plane as the relatively fixed part, by simply pulling upon a cord or cords at one end of the structure.

WINDOW SCREEN.—F. S. BANKS, R. F. D., No. 42, Norwalk, Conn. The invention has reference to improvements in window screens, and has for an object the provision of an improved structure in which the frame may be adjusted at each end so as to adopt the same to various widths of windows within certain limits.

Machines and Mechanical Devices

EMBOSSING MACHINE.—O. E. STRAWN, 818 Idaho St., Boise, Idaho. The invention relates to embossing machines of the type suitable for use in connection with the Crump process for embossing in which a fusible powder is dusted onto a freshly printed surface, the ink of which, is not yet dry, so as to cause the powder to adhere to the ink, after which, heat is applied, thus affecting the molecular condition of the powder and causing the printed letters to apparently swell and at the same time harden.

AUTOMATIC LUBRICATOR.—E. R. MCKINNIS, Address, Jos. A. Fowler, 42 W. 2d St., Memphis, Tenn. The object here is to provide means for positively feeding the sticks forwardly in the guides during operation of the elevator or like construction, of such nature as to maintain



AUTOMATIC LUBRICATOR

a substantially uniform pressure at all times, provide adjustment for this purpose, and at the same time permit of the use of springs in connection with the lubricating sticks to yieldingly hold the same at the desired pressure against the elevator guide.

COLOR PHOTOGRAPHING APPARATUS.—W. H. DOHERTY, 7 Woodward Park St., Dorchester, Mass. This camera is an improvement over that form in Mr. Doherty's application for Letters Patent, Serial No. 758,328, in that, while being an apparatus for color photography, the present form provides for either two plates in focal plane, or three plates, of different color screen results, and further, that in this present form he arranges the plates when two in number in one focal plane located in the conventional position or, when three in number, in another focal plane also located conventionally in the rear of the camera.

PAPER ENGAGING ELEMENT FOR PAPER FEEDING MACHINES.—A. BROADMEYER, Address W. O. Hickok Mfg. Co., Harrisburg, Pa. This invention relates to improvements in paper engaging elements which, in connection with a vertically adjustable table, engages the paper stack upon such table, and controls vertical movement of the table as the paper is fed from the stack, the present improvement aiming to provide a readily adjustable paper engaging element.

PAPER STACK AGITATING MEANS FOR PAPER FEEDING MACHINES.—A. BROADMEYER, Address W. O. Hickok Mfg. Co., Harrisburg, Pa. The improvements are directed to the means for directing blasts of air against the forward portion of a paper stack near the edge of the sheets of the stack at a point where they are initially engaged to successively remove the same, the improvements aiming to provide blast directing means capable of ready and quick adjustment in connection with the paper stack, as well as a wide range of action, and adapted to promote wholly effective results in such action.

SPAR POLE FOR LOG-SKIDDING MACHINES.—D. G. MANGES, Tellico Plains, Tenn. This invention provides a metallic construction including freely adjustable sheaves, certain of which receive the main or trolley cable and the others of which receive the operating cables, and all of which provide for the reception of sheave blocks in order to receive a guy wire threaded through the same and the sheave block of a single guy cable.

Musical Devices

ADJUSTABLE TONE ARM AND SOUND BOX COUPLING.—L. MARKELS, care of Sykes, McCole & Potter, 170 Broadway, New York, N. Y. This improvement refers more particularly to an adjustable connection whereby the sound box can be set to operate on phonograph records having the up and down or lateral sound undulations. It provides a pair of stops on the tone arm arranged at 90 degrees apart so that the back of the sound box body can engage with either stop and thereby be set at the proper position for operating on either type of disk phonograph record.

AUTOMATIC WINDING DEVICE FOR PHONOGRAPHS.—G. BEDFORD, 110 Malbone St., Brooklyn, N. Y. This improvement has particular reference to phonographs of the spring motor type. The primary object is to provide means whereby the spring will be automatically wound to its full capacity simultaneously with the lifting of the lid of the casing, requiring no attention whatever of the operator for this purpose.

Prime Movers and Their Accessories

MEANS FOR EQUALIZING PISTON DISPLACEMENT.—J. C. MORISON, 616 E. Hurton St., Anne Arbor, Mich. In this case the invention has reference to means for equalizing the piston displacement during each half engine stroke, and the object thereof is to eliminate vibration in reciprocating engines due to the variation in the piston displacement, particularly in those of high speed.

Railways and Their Accessories

SCALE.—G. H. KAISER, 41 E. 11th St., Portland, Ore. This invention provides a removable pivot, adjustable holder and removable holder for scales used on railroads, wherein the pivot and bearing is as arranged that it may be quickly removed for sharpening or repairs, and may be replaced by a new pivot and bearing to permit the scale to be used continuously.

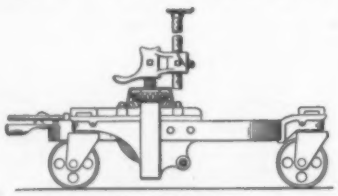
Pertaining to Recreation

SPRING-GRIP DUMB-BELL.—L. G. LEWIS, 42 Berners St., London, W., England. The uses of spring-grip dumb-bells has hitherto been liable, through inattention, to fail of obtaining the full benefit which should result from the exercise which such appliances are designed to afford. The present invention overcomes this difficulty by insuring that the user shall receive notification of the fact when his grip is closed to the fullest extent.

Pertaining to Vehicles

SIGNALING DEVICE.—T. RICHARDSON, 2016 Perdido St., New Orleans, La. The improvement provides a device more especially designed for use on automobiles, auto-trucks and other similar vehicles, and arranged to enable the operator of the vehicle to display a signal to a following vehicle to prevent accidents when stopping or turning out.

AUTOMOBILE JACK—F. O. COOLEY and A. J. MILLIGAN, Care of Clyde Iron Works, Duluth, Minn. This invention has the following advantages: It is the only twin "auto jack" whose two sides are independent of each other, it being possible to raise, stop or lower either side at any time while operating the same; it has adjustable swivel seats to clear truss and steering rods; in raising or lowering the full



AUTOMOBILE JACK

force is obtained on the sides alternately, that is, one side raises on the up stroke as does also the opposite on the down stroke; it is impossible to tip or drop the load in the various operations; has ball bearings throughout; and may be used as jack, turntable or transport, and to test the emergency brake, and repair tires, springs or wheels.

Designs

DESIGN FOR A DRINKING VESSEL OR SIMILAR ARTICLE.—W. J. GRAHAM, Bellaire, Ohio. This ornamental design for a drinking vessel shows an article somewhat elongated and tapering slightly from top to bottom. The form is simple but exceedingly attractive and the design is beautified by a running vine around the vessel.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Machine Guns by the Thousands

(Concluded from page 69)

assembled therefrom. These guns invariably operate perfectly. This feature of interchangeability is essential, for it makes possible the utilization of the parts of two or more damaged guns in making one good gun, on the battlefield.

The guns are fitted to their individual tripods by the Russians, who number the tripod the same as the gun and stamp both with their metal stamp, which is a signal that the gun has passed all inspections and is officially accepted.

The tripod of the Colt gun, at the beginning of the present war, was three feet or more in height, and the gunner sat on a bicycle saddle placed on the rear leg. But the flat plains on which the Russian armies are waging their major campaigns make necessary the employment of extra low tripods. The present tripods are slightly over a foot in height, and are provided with an arm rest so that the gunner, laying flat on the ground, can place his arms on the rest so as to permit of steady aiming.

The packing of the guns for shipment is conducted with the greatest care under the supervision of a Russian inspector. In order to protect the metal parts against rust all the guns and extra parts are liberally coated both inside and outside with a heavy gun grease or rust preventive. The guns and barrels so coated are then inserted in their respective leather "boots" or casings, and placed into wooden cases which are sufficiently heavy to protect their contents throughout the journey almost half-way around the globe.

It seems hardly possible that an idea entertained by a group of men less than a year ago should have developed into what is probably the largest machine gun producing plant in the world, yet such is an accomplished fact. And it is certainly comforting in times like the present for Americans to know that we have such progressive plants as this one, ready for instant service in the hour of national need.

Simple Methods of Determining Rifle Muzzle Velocities

(Concluded from page 60)

the camera did not show up anything on account of the diaphragm stop having been set at 64.

The gravity method, although seemingly easy, frustrated two attempts at a determination. Obviously, the chief point in that method is to get the gun barrel horizontal. In the author's experiment a sight was taken from a surveyor's level to about three hundred yards distant and a target there set up with a line marked on it coinciding with the line determined by the horizontal wire in the instrument. No correction for curvature of the earth here has to be made for obvious reasons; the bullet falls out of a straight line only for the formula to hold. Next, a target was set up in the same line of sight at 100 yards distant and the same process gone through with. Following, an upright was set up about 6 feet from the instrument and made fast. It was intended that a sight should be taken on this and a point made in the line of sight at which a hole was to be bored to receive the end of the rifle. But the instrument happened to be a long focus one and the upright could not be seen; nevertheless, the hole was placed on estimate. Another upright was then erected within a few inches of the instrument and another hole bored. The rack holding the gun was run up and down through these uprights. The necessity for estimating the two holes, however, proved to be the undoing of the experiment for the values were not concordant nor true. Another attempt will probably be made at a later date with better apparatus.

In conclusion, if the determining of the muzzle velocity of a rifle is of great import to anyone—such as the government testing stations or arms manufacturers, a special set-up of such a device might prove of value. The gravity method assuredly would give better values than either the ballistic pendulum or the electric screen method.

What the French Helmet will Stand

(Concluded from page 60)

grin, trotted out a box of special match ammunition yclept "Palma," after the celebrated long range match for which it was loaded. This uses a bullet of 180 grains instead of 150, with the same muzzle velocity. At the muzzle it strikes a blow of 2900 foot-pounds.

The big bullet merely shattered itself against the helmet, to the abject amazement of the powder man. This bullet, by the way, in the hands of the writer, has shot through half-inch plates of boiler-steel at the muzzle, and through quarter-inch plates at 500 yards. The helmet was merely rested against a head-sized rock to give natural conditions—not that the head of the poilu is akin to a rock, but this was the nearest approach possible with the limited equipment available. A second bullet, in practically the same place, still failed to get through. And at the range of 40 yards the experimenter smote the helmet again and again in nearly the same spot, until finally the eighth shot shattered the helmet into pieces at the point of the terrific pounding.

Each time of course the impact of the bullet drove helmet and rock through the air, and a solid support to the steel might have told a different story—but the helmet on the head of a man is not solidly supported. When the eighth Palma bullet finally shattered the helmet the pleased strangers carefully gathered up all the fragments and thanked the shooter and went away never to return.

Later, upon telling the officials of the Government Frankford Arsenal about the trial, the powder man met with laughter, jeers and contumely, the Government men refusing to listen to such a yarn. The peeved powder man wrote the company making the helmets—or the steel therefor—asking for one to demonstrate to the Government officials, but met with polite refusal, nor has he seen a helmet since.

The helmet tried out weighed as near as the experimenter could tell, about 6 pounds, shaped like the helmets shown on French soldiers in the photographs from the front, and supported on the head by a light framework akin to the sun helmets worn in the tropics. Evidently the material was some alloy like tungsten, heat-treated, and not only hard, but tough. The shattering under the final blow indicated a glass-like hardness that was still devoid of the brittleness of most very hard and thin steel plates.

The writer, probably like most persons not on the inside, took it for granted that the helmet of the French and British was merely a protection against shrapnel, which has no great punch, and little penetration, being merely half-inch lead balls, travelling with the remaining velocity of the shell at its bursting point, plus about 200 feet per second imparted by the bursting charge within. As the shell itself has but 1700 feet per second initial velocity, and probably not over 900 or 1000 at the bursting point, the best laid shrapnel merely means a shower of round leaden balls with velocity not exceeding 1200 feet per second, and probably nearer 800 as the average. With the scanty penetration of the round missile, this 170 grain leaden pill with its low velocity would be halted by almost any discouraging obstacle.

But a helmet that will resist the impact of a bullet of 180 grains, sharp pointed, 30 caliber, and travelling at 2700 feet per second, is a different thing, more especially since care was taken, according to my informant, to make the impact of the bullet at right angles to the steel. A helmet capable of such resistance, would nine times out of ten turn a bullet from the German rifle fired at a distance of 200 yards or more and do it without serious injury to the soldier because of the sloping form of of the helmet, and the difficulty of getting a right-angled hit against the steel. The spitzer form of bullet is easily deflected against a sloping surface, more easily than the older form of blunt nose, the long shoulders sliding neatly off inclined surfaces which the blunt nose bullet, with more "biting" area to its point, would penetrate.

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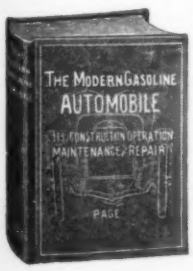

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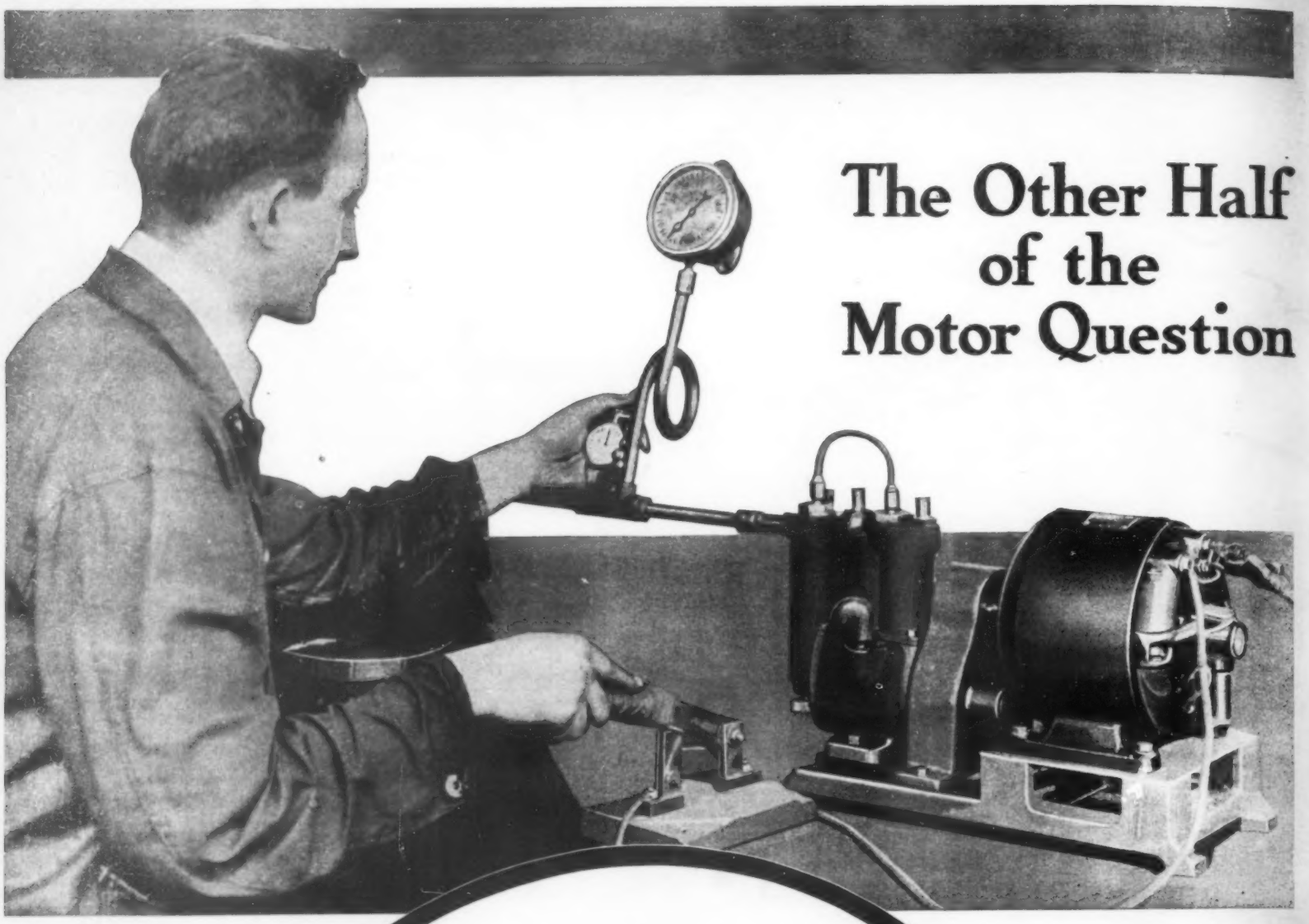

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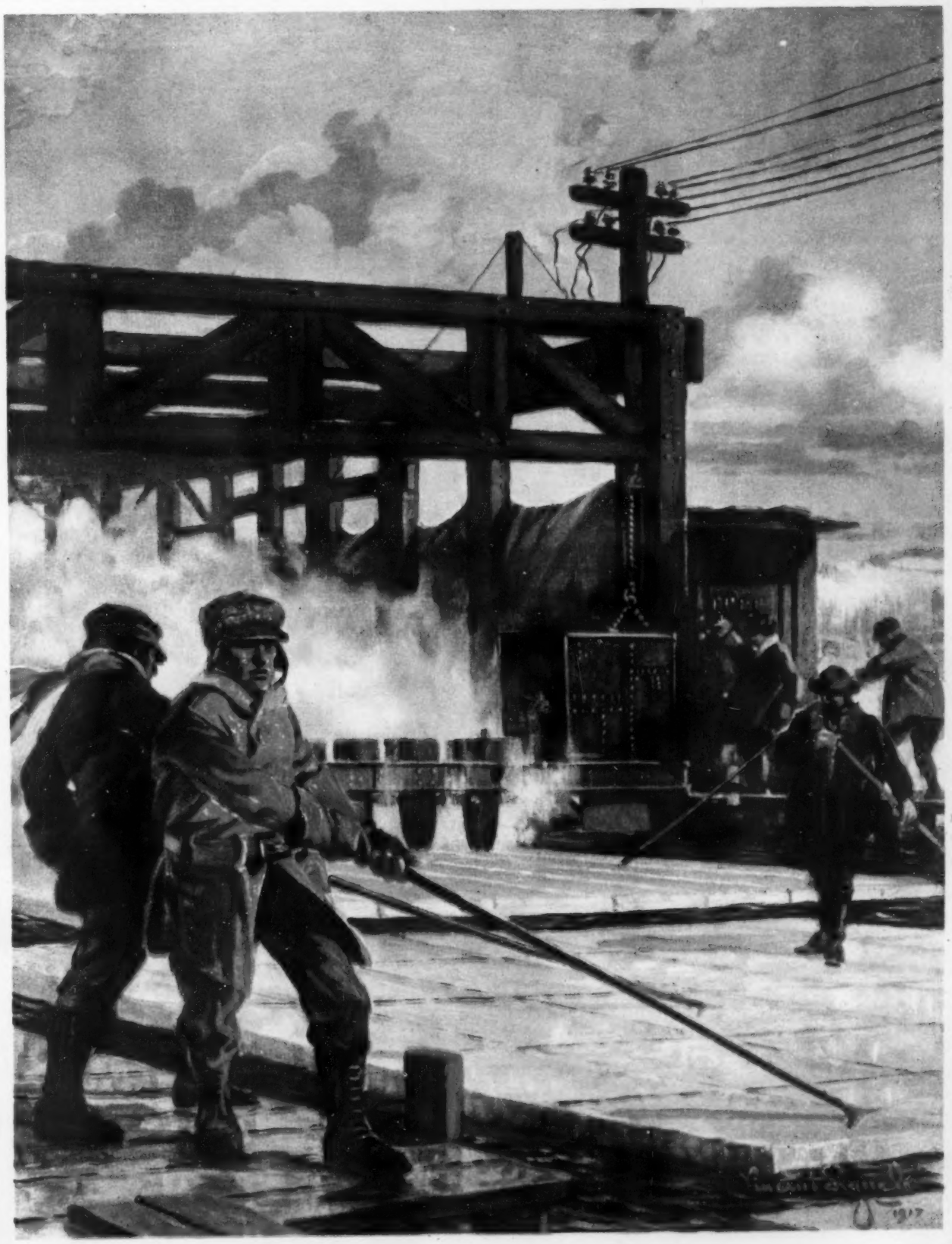

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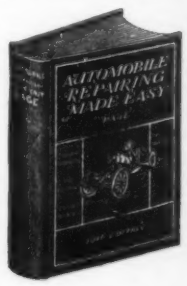

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